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Economies of Scale, Natural Monopoly and Imperfect Competition in an Experimental Market

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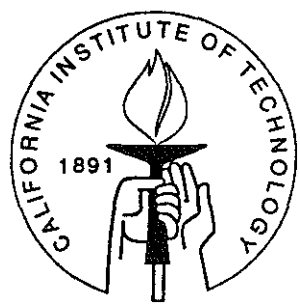

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ABSTRACT

This paper reports on the behavior of markets in which all agents have identical costs with economies of scale over the entire range of demand. Each firm, by choosing a larger scale of plant and a larger volume, can experience lower average cost. Thus the markets are characterized by the fundamental technological property that has motivated decades of theorizing about natural monopoly and imperfect competition. The primary question posed by the research is whether or not a natural monopoly emerges and sets prices at monopoly levels or whether the data are more closely approximated by some alternative model of imperfect competition such as monopolistic competition, Cournot oligopoly or contestable market theory. The results are that monopoly emerges and charges prices closely approximated by contestable market theory. No support is found for Cournot forms of oligopoly or for other types of monopolistic competition.

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1 Introduction

This paper reports on the behavior of markets in which all agents have identical costs with economies of scale over the entire range of demand. Each firm, by choosing a larger scale of plant and a larger volume, can experience lower average cost. Thus the markets are characterized by the fundamental technological property that has motivated decades of theorizing about natural monopoly and imperfect competition. The primary question posed by the research is whether or not a natural monopoly emerges and sets prices at monopoly levels or whether the data are more closely approximated by some alternative model of imperfect competition such as monopolistic competition, Cournot oligopoly or contestable market theory.

Some of the principle results of the experiments reported here can, in retrospect, be interpreted as having been anticipated by the pathbreaking work of Coursey, Isaac, and Smith (1984), and by Coursey, Isaac, Luke and Smith (1984). While these previous experiments involved economic environments that were much less complicated than the one studied here, the tendencies previously observed are clearly present in the behaviors reported here. So, in a sense, the results reported here can be interpreted as a major extension of the previous results as well as replication, and robustness check.

The similarities of experimental design with previous experiments rest on the facts of falling average cost and no barriers to entry that existed in all experiments. However, the number and nature of departures from the previous research are substantial. The markets studied here were much larger so parameters took values in a more continuous manner. The experiments studied here involved two markets so entry into the falling

[1]This paper began with a project in an experimental economics class at Caltech in which G. Elbaz and A. Sugiyama were undergraduate students. In addition to the authors, Peter Ying contributed to the project during the initial stages of research. The comments of William Novshek are also appreciated. The financial support of the National Science Foundation and the Caltech Laboratory for Experimental Economics and Political Science is gratefully acknowledged.

average cost market was accompanied by the opportunity cost of profits foregone in the alternative market. The alternative market was a computerized double auction which agents generally enjoy so entry into the falling average cost market did not result from an attempt to relieve boredom which one might have suspected played a role in previous studies. Agents entering the falling average cost market were required to make a choice of scale of plant that affected costs. Thus the theory of cost minimization played an active role in developing models. This dimension was completely absent from previous experiments. Previous experiments used linear average costs that fell with volume until a capacity constraint was reached (within the range of demand) and then costs became vertical. Average costs in the experiments reported here were nonlinear and fell throughout the range of demand. In addition, the nonlinearities, scale economies and demand were configured to create Cournot equilibria in the appropriate Cournot model of the environment. The Cournot equilibria were separated from the competitive (price equals average cost plus opportunity cost) equilibrium. In previous experiments the Cournot equilibrium was also the competitive equilibrium. The number of potential entrants used in previous experiments was small, ranging from two to four. In the experiments reported here there were seven potential competitors. Briefly put, the choice of parameters for the experiments reported here was such that the economic environment was similar to those commonly found in the figures in economics textbooks.

II. EXPERIMENTAL ENVIRONMENT, DESIGN AND PROCEDURES

A total of three experiments were conducted. Subjects were students at the California Institute of Technology and summer interns at Caltech. Some of the subjects were experienced in the operation of electronic markets. As it turns out, the empirical tendencies that were observed in the experiments are so pronounced that only three experiments appear to be needed to answer the original question posed. Since the experiments are expensive in terms of time and money, a decision was made to limit the number of experiments to three. Given the behavior exhibited by the twenty one people studied, the expectation that anything would be learned from additional replications seems too low to justify the cost.

Each experiment consisted of 7 buyers and 7 sellers. Subjects with experience were placed in the more complex roll of sellers. Two markets were created. They will be called market A and market B. The buyers could participate in both. Sellers could participate in either but not in both. In market A sellers had identical cost functions designed such that they were guaranteed a rent from participating in the market. The parameters were chosen such that in market A the rents per seller and the market price were (theoretically) independent of the number of sellers that chose to sell in that market. Market A was organized by a (computerized) double auction that fully occupied the attention of the sellers that chose to function in that market so they would not be motivated by boredom to enter market B.

Market B was different. Sellers that chose to operate in market B made irrevocable decisions about scale of plant, the quantity that they would offer for sale and the price they would post. Thus the market organization was the standard posted price environment in which commitments were private information until the market opened. The only difference was that a seller could choose to drop out of the market once the decisions of other sellers were public but before the market opened. The decisions to drop out were also private (revealed simultaneously) and irrevocable. The dropout decision served to limit losses to the opportunity cost of market A profits foregone, and reduced the probability that subject bankruptcies would disrupt the experiment. In market B all sellers had the same cost function. The cost function was characterized by economies of scale.

In summary, the economic environment had the following properties.

1. Participation in market B involved an opportunity cost because reasonably predictable rents could be gained from participation in market A.
2. Participation in market A was "fun" in the sense that many people enjoy the speed and activity of the computerized double auction.
3. Participation in market B could be done without exposure to a major out–of–pocket loss due to volume being less than was anticipated at the time of the choice of scale of plant.
4. All transactions took place in a currency called francs. Each franc was converted to dollars at a rate of *.0075* for buyers and *.006* for sellers.

A. The Market Environment

A continuous approximation of market demands for markets A and B are contained in Figures 1A and 1B. The equation for the continuous approximation of the market demand in market B is

$$P = 1110 - 25x \tag{1}$$

Individual parameters for the demanders are in Tables 1 and 2. Each of seven demanders made money by participating in market A and in market B. Each buyer had the same redemption values in market A each period. That is, in market A both the market demand and the individual redemption values were constant over periods. In market B, the market demand was constant over periods but the redemption value of each individual changed from period to period. A fixed family of schedules found in Table 2 was rotated among the individual demanders. The rotation of schedules among demanders is shown for each period in Appendix A. The rotation convention was used because uncertainty about which model might be most accurate gave us little confidence in our ability to predict incomes of buyers. We wanted the income of all subject buyers to be sufficiently

high to keep their interests. The rotation had a useful feature of removing dramatic asymmetries.

Each of seven sellers had identical costs throughout the experiment. The fact that the costs were identical was not known by any agent in the markets. Each had the option of participating in either market A or in market B but not in both. A seller that participated in market A used the cost schedule in Table 1. For a single seller the graph of the (marginal) costs are included in Figure 1A. As can be seen, the seller had two low cost units and then had constant cost afterwards for enough units to satisfy the entire demand.

Given these individual costs in market A, the market price (according to the competitive model) will be constant at 700 at all volumes near the demand (at 21 units) regardless of the number of suppliers in market A. As will be stated more clearly below, the equilibrium price will be near 700 and rents for all sellers in market A will be about 300 (2 units at 150 = 700 − 550 each) regardless of the number of other sellers in market A as long as there are at least two.[2]

The costs of all seven suppliers were the same for market B. Each subject had separate tables (in different colors) for marginal cost, average cost and total cost. The total cost table is shown as Table 3. As can be seen, costs depended upon both scale of plant and volume of sales. The other tables are included with the instructions in Appendix B.

A continuous approximation to the underlying discrete parameter cost function has been useful in the development of behavioral predictions as well as experimental design decisions. Figure 2 contains a graph of the long–run average cost curve in this continuous model, and also the short–run average costs for selected scales of plant. A continuous approximation of the market demand curve is imposed over the average cost for comparison.

The formula for the competitive model is as follows. The model is restricted to the values of parameters in the range of the tables of costs. The model begins with *short–run average cost* (SRAC) which depends upon output and the scale of plant (x, s). In the discrete values of costs in the table the scale of plant is indicated by letters of the alphabet starting with the letter A. In the continuous model if scale is A then $s = 11$; if scale is B then $s = 12$, etc., with a change of one in s as the letters change.

$$\mathrm{SRAC}(x, s) = \frac{3}{4}(x - s)^2 + \frac{1}{4}(s - 40)^2 + 300. \tag{2}$$

[2]Typically two or three sellers are enough for competitive equilibrium behavior in a double auction market.

The optimum scale of plant given a quantity x is indicated by $s^*(x)$. The formula is

$$s^*(x) = 10 + \frac{3}{4}x. \tag{3}$$

Substituting (3) into (2), the *long-run average cost* function, LRAC(x) is obtained.

$$\text{LRAC}(x) = \text{SRAC}(x, s^*(x)) = 600 - 15x + \frac{3}{16}x^2. \tag{4}$$

Of course this yields the *long-run total cost* (LRTC) and the *long-run marginal cost* (LRMC) as follows.

$$\text{LRTC}(x) = 600x - 15x^2 + \frac{3}{16}x^3 \tag{5}$$

$$\text{LRMC}(x) = \frac{\partial \text{LRTC}(x)}{\partial x} = 600 - 30x + \frac{9}{16}x^2. \tag{6}$$

The continuous model will be very useful to the interested reader. The complicated calculations for the equilibria of various models were first done in the context of the continuous model. The location of the equilibria in models based on discrete parameters was always nearby.

B. Market Organization

Market A was a computerized double auction. Market B was a posted price market. Both markets opened at the same time for trading. Sellers were informed about the market demand function in market B but they knew nothing about the market demand function in market A. Since market A followed standard procedures for MUDA markets,[3] only the timing and the details of market B need to be reviewed.

Before each period all seller agents were required to decide which market they would enter. After deciding they (privately) drew a large X through the record sheet of the market not chosen. Agents choosing market B would then fill in the blanks on their record for the period committing themselves to a scale of plant, a quantity to be offered and a price. The computerized MUDA program allows the simultaneous operation of

[3]See Plott and Gray (1990) for a detailed description of this market, or see Plott (1991) for a description of the computerized version.

multiple markets. Each of the seven sellers was assigned to a "personal market" in which no other seller could participate. The sellers would enter their (price, quantity) pairs in an order box fixed on their individual markets. At the appropriate (public) signal each seller would press the enter key thereby making their private decisions public to all buyers and sellers as they were displayed by the computer as asks (to sell) in their individual markets. Once sellers had seen the asks of other sellers, they had the opportunity to cancel their own asks. This was done simultaneously on signal. Sellers canceling asks were not permitted to enter the A market. They did nothing for the remainder of the period. Thus sellers who entered market B and canceled experienced the opportunity cost of A profits.

After sellers who had made the decision to enter market B had the opportunity to cancel, all markets opened for trading. Market A proceeded along the standard lines for the computerized MUDA. In market B, sellers who remained each had a price posted and a maximum quantity. At any time during a period buyers could toggle to any of these markets and purchase the number of units desired at the posted price up to the amount for sale that the seller had left. Buyers could only accept the asks in these markets. That is, they could not tender bids in any market except market A.

A comment about the organization is in order. Market A was a double auction and it existed as a source of income and entertainment for those who chose not to enter market B. Market B was a posted price market because it is thought to provide the best circumstances for monopoly behavior (Smith, 1981). When the demand function is known and prices are posted, the seller is most likely to successfully charge monopoly prices. Double auctions are known to have strong tendencies to converge to a competitive equilibrium even in the presence of monopoly. If market B had been a double auction then any tendency to converge to a competitive equilibrium could have been attributed to the market micro structure alone, as opposed to the industrial organization. Thus the posted price institution was thought to be a more favorable environment for the emergence of monopoly pricing than the double auction.

The cancellation property is important as a risk reduction feature in this type of market. If a seller chooses a large scale of plant and succeeds in selling only a few units, large losses can be experienced. Buyers have the capacity to punish high–priced sellers by purchasing only a unit or two. Similarly well meaning buyers who want to share the volume by spreading purchases over sellers can be very costly to a seller who does not otherwise get the volume. Likewise, accidental purchases can be very costly. Cancellation allows those sellers who choose relatively high prices the opportunity to avoid such risks.

The experiment contained one other special feature. A market demand function for market B was privately distributed to the sellers on a sheet of paper. All sellers knew what it meant. The demand function given sellers was actually 10 francs below the actual induced values. Buyers typically do not trade without a small profit margin for themselves. We believed that the function we gave them was a better model of what they would experience than would be the actual limit values.

C. Procedures

The experiments were conducted in the Laboratory for Experimental Economics and Political Science at Caltech. Subjects consisted of undergraduates, graduate students at the California Institute of Technology, plus high school students who were attending a special summer program. Most had previous experience in some type of computerized market. All had paged through a computerized instruction routine that familiarized them with key functions and the mechanics of making bids, offers and acceptances.

In addition to the three experiments reported here, pilot experiments were conducted. The pilot experiments were discarded because they typically involved choices of parameters that were based on a miscalculation of the theoretical models. The parameters and procedures of one experiment were exactly like those reported in this paper but the data are not reported because one subject evidenced substantial confusion. The results of these unreported experiments appeared qualitatively similar to the experiments that are reported here. Space constraints effectively preclude their publication. Should anyone want to study them in detail, the data will be made available upon request.

Experimental sessions which lasted on the order of three hours began in the evening at about 7:00 P.M. The detailed instructions that were read to the subjects are contained in the Appendix. In addition, the material presented on the chalkboard and the step–by–step procedures for conducting the experiment are also in the Appendix.

The highlights of these experimental procedures are as follows. Subjects were paid a "show up" fee of $5.00 if they were extras and were turned away from participation. Subjects agreed to work off any losses incurred during the experiment at a rate of $10.00 per hour. Of course buyers could make no losses unless they resulted from some sort of (foolish) speculation or from a typo. Contracts involving obvious typos that would result in large losses were always voided by the experimenter (a standard practice). However, sellers could make a loss. If a seller entered the B market at a substantial scale of plant and sold only a small number of units the losses could be considerable.

Sellers who wanted a sure return could participate in the A market. The design of this market was such that a rent of $1.80 per period was almost certain for participation in market A and the seller was exposed to no possibility of a loss. On average each

participant made approximately $30 from the experiments.

Each seller was provided cost schedules for market A sales.[4] For market B each seller had color–coded tables that gave marginal cost (pink), average cost (green), and total cost (yellow) of combinations of volume and scale of plant on 11 by 14 sheets of paper. These tables are in the Appendix. Scale of plant could take 24 values, labeled A through Y.

Two practice periods were conducted. The parameters were the same as those that were used in the experiment. The mechanics of the experiment were very complex and many questions were prompted during these sessions. The answers to all questions were given publicly in a form that yielded no information about parameters that was not already public. After each period for the first five periods (including the two practice periods) the accounting of each subject was checked and spot checks were made throughout the experiment.

III. MODELS

Ten different types of models can be applied to the economic environment. Of course these models share many basic principles but they also differ in many ways. Some give sharp predictions and the others remain vague. Where possible the models will be applied directly to the environment in a technical, mathematical fashion. Speculations and theorizing about which model might be expected to fit the data best are not considered to be part of the exercise at this stage of the experimental inquiry. Table 4 contains a summary of the predictions for those models for which predictions can be computed. The paragraphs below will briefly describe each model listed in the table.

A note on efficiency may be useful especially for those who are not familiar with experimental economics. The measure invented by Plott and Smith (1981) is a direct adaptation of consumers' and producers' surpluses. The buyers receive franc redemption values from the experimenter that can be modeled as a (derived) demand function. The total value of francs redeemed by buyers is like the gross benefits to buyers from the units they acquired. Sellers pay francs to the experimenter for units sold. These payments are costs. The allocation that maximizes gross benefits minus costs is the most efficient. It is the one that maximizes franc earnings of subjects (exhausts all possible gains from exchange). Actual franc earnings divided by the maximum possible is the efficiency with which the system is operating.

Under ordinary modes of organization, 100 percent efficiency of operation is thought

[4]A rounding error caused a slight discrepancy between these schedules. For example, total cost at the contested market equilibria of scale W and volume 31 was 9765 if computed from the average cost table and it was 9773 as listed on the total cost schedule, a difference of 4.8 cents.

to be unattainable in the downward sloping average cost case. If a single price is charged and if price is equated to marginal cost then sellers would lose money. This degree of inefficiency is thought to be structural in the falling–average cost case.

Other practical sources of inefficiency exist. Tough bargaining sometimes results in failures to trade. Suppliers might choose the "wrong" scale of plant and thereby impose more costs on the system than necessary. Suppliers might choose to enter the B market and then cancel. The efficiency loss would be due to the opportunity cost of the low cost units that such suppliers could have delivered to the A market. Suppliers might choose an unnecessarily limiting quantity of x offer to the market B. In the section on models the efficiency of the equilibria allocation predicted by each model is listed. The logic of each of these models justifies the nature and potential reasons for inefficiencies.

Natural Monopoly (Classical)

The classic model is natural monopoly. According to this model, because of the existence of economies of scale, competition will lead to the existence of a monopoly. All other sellers will participate in market A. This monopoly facing the market demand curve will choose the profit maximizing value of variables without regard to the effect that this action might have on the actions of other sellers such as their proclivity to enter market B. That is, where $P = D(x)$ is the market demand function and long–run costs are $C(x, s(x))$ the monopolist sets the value of the variables to

$$\underset{x}{\text{maximize}} \quad [D(x)x - C(x, s(x))].$$

For the parameters of the experiment the solution is a price of 684, a quantity equal to 17, a scale of plant of size M and a profit of 4841 in francs. These can be read from the table. Figure 3 demonstrates the model. For convenience the continuous model, which is only an approximation of the underlying parameters, is used in the figure. The accurate predictions based on the discrete environment are in Table 5.

Tacit Collusion

Collusion models are very numerous depending upon the complexity of the agreement that can be enforced. It is assumed here that collusion would lead to choices of variables that are good from the seller's point of view. We presume that the values would be something between Cournot and monopoly and that the volume would be similarly restricted.

Cournot Models

Cournot models are all derived from the same general principles. Each competitor evaluates the market as if the quantity offered by the other sellers is a constant and

the resulting market price is that determined by the sum of the quantities offered by sellers. For insights about the structure of these models, especially in the presence of non convexities as in the case with economies of scale, see Novshek (1984)(unpublished).

Application of the class of models to any real market, especially the ones created for these experiments, might be met with three *a priori* criticisms/qualifications. First, the Cournot solutions to the technical problems are generally not unique. Typically both symmetric solutions in which all firms act identically and asymmetric solutions, in which some firms are larger than others, exist. The symmetric solutions and those asymmetric solutions that have been identified and seem plausible have been included in Table 4. The second qualification is that the principles that might govern entry into a market are not systematically integrated (unless lack of entry is treated as part of an asymmetric solution) into the analysis. For this reason, a special treatment of Cournot models under a heading called monopolistic competition is included. The third criticism is derived from the nature of the market structure itself. Agents in these markets post a price and a quantity. There is every reason to assume that the seller with the lowest price will sell all units that the seller offers up to the demand function limits. The hypothesis that the quantity sold by other sellers remains constant will almost certainly be violated. Thus the structure of the decision problem might appear to resemble that of the Bertrand theory more than Cournot depending upon how the posted quantity is treated in the analysis..

All of the criticisms/qualifications are derived in part from the fact that the Cournot model is incomplete as a theory. It is silent about the nature of the price determination process. If sellers (or buyers) are supposed to be involved in price determination then some sort of explicit coordination device must exist that guides sellers to settle on the same price and guides buyers so that sellers share market volume in a Cournot fashion. Instead of dealing with all of this complexity, the Cournot model relies only on axioms typical of game theoretic representations of markets that assert that only one price exists and further asserts that the one price is determined by the law of supply and demand once sellers' quantity choices are given. Nevertheless, Cournot models have broad experimental support and must be taken seriously in any environment until the data suggest otherwise.

The Cournot solutions for duopoly and for triopoly are also in Table 4. Notice that the price predicted is 609 regardless of the number of firms. Of course firm size must decrease as the number of firms increases. This means that the scale of plant chosen by firms must be smaller under triopoly than under duopoly.

Monopolistic Competition

The classical model of monopolistic competition is interpreted as a four firm Cournot market. Scale of plants are small in the equilibrium and the opportunity cost of 300

francs ($1.80) is barely covered by the 350 profit. Entry of another firm would force the profits to levels below the opportunity costs. In the table the Cournot equilibrium profits for quintopoly, a fifth firm, are less than the 300 francs opportunity cost for entering the B market. Again, notice from the table that the price predictions are the same regardless of the number of firms.

In Figure 4 is shown a representative firm in the four firm equilibrium. The background shows the market demand function. The costs graphs are from the continuous approximation of costs given by equation (4).

Contested Markets

The contestable market literature has motivated researchers to look for two different types of phenomena in experimental data. The possible phenomenon are called "models" here, but they operate more like statements that characterize the extremes of what one might expect in data. Of course those extremes and the relative tendencies toward them contain potentially useful information.

Perfectly Contested Market (Competitive) Equilibrium. This is the case in which only one seller exists in the market. The seller produces at a price and output that leaves price equal to average cost including opportunity cost. The profits in market A and market B would be the same (thereby justifying the use of the term "competitive"). As indicated in the table, the price of the single entrant would be 325; volume would be 31; scale of plant would be W and the other six sellers would be in market A. The relationships are in Figure 3.

Without side payments such as a subsidy to compensate a firm for losses and a completely different institutional arrangement, such as marginal cost pricing or the incentive compatible equivalent, average cost pricing might be the best that can be expected from a consumer's point of view. It is used as a measure for 100 percent efficiency.

Over–Contested Market Equilibrium. This model postulates that the price and quantities sold would be the same as the perfectly contested outcome above. The only difference is the number of firms that have decided to enter. Previous experiments have defined this model to predict that all of the potential firms enter. Obviously, the plausibility of such phenomena would *a priori* seem low but this model is included as a benchmarker for completeness. The number, (5), is taken to be the maximum that could leave market A and still have it behave competitively.

Unstable ("Bertrand")

We do not know the equilibrium of the Bertrand model of these experimental markets.

Presumably it involves some sort of mixed strategy. In the data this would appear as a type of variability in prices. At this point the model is included for completeness and to draw attention to the possibility that the data might not exhibit any type of monotone convergence property. It is also included to draw attention to the fact that the literature contains suggestions about how such variability phenomena might be modeled should it be observed.

Market Collapse (Type 1)

Entry into the contested market will involve a cost. The possibility of out–of–pocket losses also exists. Since there are no mechanisms for coordinating entry, sellers might all decide to operate only in the A market. Under such a circumstance the supply in B would be zero. The market would have collapsed. Type 1 collapse is the case when no firm enters the B market.

Market Collapse (Type 2)

The second type of collapse can occur when more than one firm decides to enter but all cancel leaving no one to supply the market. This is a type of coordination failure which can occur because the decisions to cancel market B offers are made simultaneously.

IV. RESULTS

The central results are easy to state. The contestable markets model is the most accurate of those considered. After a brief review of the data, the discussion turns to making clear the strength of this central proposition. Following the main results, the remainder of this section is devoted to a discussion of a series of five observations about both individual and systems behavior.

A typical price time series for both markets are shown in Figures 5 and 6. Figure 5 contains the time series for market A, and Figure 6 contains the time series for market B. Vertical lines separate periods. The measure of time differs in the two figures. In market A the measure is seconds. In market B the measure is the number of events (e.g., asks, contracts) because the high speed with which events occur in clock time make them indistinguishable given the units (seconds) in which clocktime is measured.

The horizontal lines in the figures show the price predictors for various models. The top line is the monopoly price. The second line is the price predicted by all Cournot and monopolistic competition models. The bottom line is the "competitive" price predicted by the contestable–market model. Contracts are indicated by circles in both the A market and the B market; and in market B the prices posted by sellers are displayed by small triangles. Cancellations in the B markets are not shown but in most cases all sellers in

the B market canceled except the seller with the lowest posted price.

Figure 7 contains the price and volume data pooled across all experiments. Each dot represents a period in one of the three experiments. The market demand function and the predictions of selected models are also shown in the figure.

The visual impressions are that prices converged to the competitive equilibrium in market A and that prices converged to the one predicted by the contestable–market model in market B. These visual impressions are essentially correct. The first results reported in this section make the nature of the data that support these impressions precise.

The first result is a traditional statement intended to prevent any misconceptions about what is being reported. Sometimes experimental data are predicted by models in an accurate statistical sense. However, in most cases none of the models are statistically accurate. The first result makes clear that these models contain unanticipated and unexplained errors and thereby sets the stage for all subsequent analysis.

Result 1. All models can be rejected as a statistically accurate representation of the data.

Support. All models are static equilibrium models. However, the data for the B markets such as the one contained in Figure 6 exhibits an obvious type of convergence pattern which is not captured by any of the models even if a random error term is added. In the absence of additional theory appended to the models to take care of the dynamics, the models are rejected. □

The second result is perhaps the central result of the paper. It states that the contestable market theory is the one best supported by the data.

Result 2. After the first six periods all relevant economic variables (prices, volumes, profits, scale of plant choices, and efficiencies) are closer to the predictions of the two contestable market models than to the predictions of any other model.

Support. Each of the variables will be discussed in order. All models predict competitive behavior in the A markets. The competitive price is 700 and the volume is 21. In 49 of the 57 periods of all experiments the average price of the period was within 10 francs (6 cents for sellers and .75 of a cent for buyers) of the competitive equilibrium. In 56 of these periods the volume was within 3 units of the 21 predicted and in 41 periods the volume was exactly 21 units. The relevant data are in Table 5. Since the price and volume in the A markets behaved substantially as predicted by all models, the relevant comparisons are all in the B markets.

In the B markets prices and volumes tended to be closer to the contestable market models than any of the others. In 52 of the 57 periods, prices were within 10 francs of the price predicted by the contestable–market models (325). In no period was the price within 10 francs of the price predicted by the natural monopoly model (680), and in no period was the price within 10 francs of the price predicted by any Cournot model (609). The count comes directly from the data in Table 5 and the predictions in Table 4. Similarly the volume was within three units of the contestable market prediction (31) in 47 of the 57 periods. It was never that close to the prediction of the natural monopoly model (17), and it was within three units of the predictions of the Cournot models (20) only in two periods. Price and market volume figures support the contestable–market model over the others.

Volume of individual firms further support the contestability model over the Cournot models and the monopolistic competition models which, because of symmetry assumptions, predict that all B market entrants will have the same volume. In 54 of the 57 periods only one firm had positive sales in the B market. Thus, in 54 of 57 periods the data support contestability over monopolistic competition. In none of these three periods in which more than one firm made B market sales, was the distribution volumes near equality as predicted by the symmetric game models. As will be implicit in the discussions below, sellers that chose to enter the B market did not limit their quantities as required by the Cournot model and as they could have done under the procedures.

In market B profit levels predicted by competing models are in Table 4. Profits should be at or above 300 which is the (nearly) certain profit that can be obtained for participation in market A. The listing of actual profits of sellers in market B are in Table 6B. The "active" firms referenced in the table are those that did not cancel their posted offer after they had seen the offers of other sellers. Shown also is the number of sellers that entered the B market at the beginning of the period.

Consider only the last four periods of the experiments after some level of equilibration has been achieved. The average profit of the lowest price firm over all three experiments is 562.7 francs per period. The average profit of all entrants is 229.25 francs per period. Thus the average profit of sellers who entered market B is closer to the 306 predicted by the perfectly contested model than to the prediction of any other model except quintopoly which can be rejected since the number of sellers was always less than five. Consideration of more periods does not change this conclusion. In fact, the conclusion is only reinforced. The average profit earned per period by all entrants in market B, considering period 3 and later, for the three experiments was 4 francs, 17 francs, and 4 francs, respectively, far below that predicted by any model.

The frequency of scale of plant choices is contained in Table 7. Only three choices are at scale levels (D, E, G, and M) predicted by any of the alternative models to the

contested market model. The contested market model predicts scale W which is the mode of choices of sellers (41 choices out of 146 total). Over 40 percent of all choices are within one level of that predicted by the contestable–market model. The small mode at scale K is interesting because scale K was the example used in the instructions to illustrate the nature of costs.

Efficiency levels are reported in Table 5. The average efficiency level for the three experiments is .91, .91, and .90 which is much closer to the .87 predicted by the over–contested market model than it is the efficiency predicted by natural monopoly (80%), duopoly (76%), triopoly (70%), monopolistic competition (67%), or market collapse (41%). On average the perfectly contested model is a better predictor of efficiency than any of the noncontested models.

In all dimensions the two contestable market theories are better predictors than the alternative models. If one is forced to choose between the perfectly–contested model and the over–contested model the choice will be the former. The average number of entrants per period is 2.54 which is closer to the one predicted by the perfectly contested model than the five predicted by the over–contested model. □

The next five observations focus on aspects of strategic behavior and on system behavior. The first four of the observations are related to individual behavior and the strategies that individuals employ. The fifth observation is a summary property of the system as a whole.

Observation 1 suggests that people bias their choices of prices in favor of those divisible by 5 and that individual strategies exhibit a degree of modification to take advantage of the underlying bias. For example, knowing about this bias, perhaps even in their own behavior, people sometimes reduce their own price by a unit. That is, rather than quote a price of 325 an individual might quote 324; or a 330 quotation would be modified downward to 329 rather than, say, increased to 331.

Observation 1. Price choices are asymmetrically distributed downward around numbers that end in 0 or 5.

Support. Actual prices ending in 0 or 5 accounted for a large percentage of choices (71 out of 148). Of the two, prices ending in 0 were the most common, occurring 51 times. Prices in a neighborhood, ± 1, around 0 and 5, were also asymmetrically distributed, with the two numbers 9 and 4 being preferred to the two numbers 1 and 6 by a margin of 25 to 14. A hypothesis of equal probability can be rejected at .01 level of confidence. □

The second observation suggests that behavior does not reflect the belief that the behavior of others is independently random with probabilities represented by the relative

frequencies of choices. Table 8 shows the relative frequencies with which price choices were made, together with the expected profit that would result from various pricing decisions given that the choices of others are drawn with probabilities equal to the frequencies in the table. If the system was at a Nash equilibrium, then the expected profit would be the same for all price choices.

Observation 2. Pricing strategies are not Nash responses given the relative frequency of prices that was observed.

Support. Consider the potential ask prices in Table 8. The high prices in the neighborhood of 360 and 385 would yield a profit of 150 percent of the lower prices. □

The third observation is that scale choices of agents are optimal given actual volumes sold by sellers. This is particularly interesting because the scale choices are not optimal given the quantities offered for sale by sellers. Recall that sellers entering market B chose a scale, a price and a quantity offered. The observation is that the scale choice suggests that sellers (correctly) expected to sell the market demand quantity but they offered a little more than that expectation in hope that the volume would be (possibly accidentally) higher.

Observation 3. The scale chosen by agents tends to be optimum given the actual quantity sold. Actual quantity sold tends to equal induced market demand given the quote of price. Quantity offered for sale is greater than actual sales and the scale of plant chosen is too small given the quoted quantity.

Support. Figure 8 shows deviations of actual scale chosen from the theoretical optimum scale given the price quoted by the agent. If the seller has the lowest price then the demand function can be used to determine the quantity that will be sold. The quantity to be sold can be used to determine the optimal scale for that quantity. The figure shows deviations from this optimum. When 0 indicates the optimum and ± 1 indicates one letter deviations from the optimum. As can be seen in the figure, the mode of choice is the optimum given the price.

The same calculation can be made using the quantities offered for sale. Figure 9 shows deviation of scale choice from the optimum given the quantity offered. As can be seen, the scale choices tend to be smaller than this calculation of optimum. □

The next observation is that agents specialize in markets. Some agents are always in market A while others have a propensity to enter market B. Table 9 contains for each individual of each experiment, the total number of times during the nineteen periods of the experiment, the number of times the individual entered the B market. For example, the person with identification number 7 in experiment 061191 entered the B market 14

times out of the nineteen periods while person 8 of that experiment never entered.

Observation 4. The frequency with which market B is entered is not the same across sellers.

Support. Test the hypothesis that the decisions made by the two individuals with the lowest propensity to enter, were independently drawn from the same distributor as the decisions of the two people with the highest propensity. The hypothesis is rejected at the .001 level of significance. □

The final Observation 5 concerns the behavior of the whole market system. As was noted in Result 2, efficiencies are not at 100% as they should be if both the competitive model and the perfectly contested market were working perfectly to predict behavior. On average, excluding the period ones, the system of both markets is operating at an efficiency level of about 91.3%. While this is much better than the 80% predicted by the natural monopoly model or the 41% predicted by the market collapse model, these two models suggest sources of inefficiency that can be interpreted as the social cost of regulation. If more than one firm happens to enter the market there is an opportunity cost of profits foregone in market A. On the other hand, if there is under entry (no firm enters and sells) and efficiency loss will exist due to the loss of consumer surplus in market B. The observation is that the efficiency loss from these two sources amounts to about 67% of the 8.7% average loss in system efficiency (not including the first periods).

Observation 5. Excluding period ones, efficiency loss due to over entry is about 2.53% and efficiency loss due to under entry is about 3.28%

Support. If exactly one firm leaves market A and enters market B the system can operate at 100% efficiency. This maximum possible efficiency expressed as a function of the number of entrants, n is: maximum possible efficiency $= 100 - (.01476)(n-1)$ if $n > 0$. However, the maximum possible efficiency is .41 if $n = 0$. Thus, $(.01476)(n-1)$ is the efficiency loss due to over entry and .59 is the efficiency loss due to no entry (or under entry). Of course, both over entry and under entry can occur at the same time if several firms enter and all cancel their asks and thus sell nothing.

The number of firms that leave market A with an intent to enter market B each period of each experiment is contained in Table 5. Application of the formula to the numbers in the table produces for all experiments and for all periods (except the period ones), an average loss of .0253 due to over entry. The table also shows three periods, one in each experiment, in which no units were sold in market B due to no entry either by virtue of leaving market A and canceling (two periods) or by not leaving market A (one period). The efficiency loss averaged over all periods except the period ones, is 0.0328. □

If the efficiency losses identified in Observation 5 are interpreted as the cost of market regulation then the overall average efficiency loss of 8.7% can be decomposed into an implicit regulatory cost of 5.8% and "other inefficiencies" of 2.9%. Of course, whether or not this is the least expensive regulation possible is not addressed here. The major point is to identify the inefficiency and demonstrate that it can be measured.

Once the "regulatory cost" or "uncoordinated entry cost" is removed, the remaining 2.9% efficiency loss is of interest. This percentage represents the combined effects of typos, wrong scale choices, inefficiencies due to strategic maneuvering, inefficiencies due to posted prices above average cost, etc. The fact that the combined effect of all sources of inefficiency is small, strongly suggests that, with the exception of uncoordinated entry, the perfectly contested market theory is predicting almost perfectly. That is, the cost expended on this form of regulation has been almost perfect in achieving its desired effect.

CONCLUSIONS

This paper posed a series of questions. First, will increasing returns result in a single seller? Will the single seller charge a monopoly price? If a monopoly price is not charged, do models exist that accurately predict what the price will be?

The answer to the first question is yes. For the most part all sales tend to be made by a single agent. This is a particularly interesting result since neither monopolistically competitive or oligopolitic structures tended to evolve even though they could have. In particular, the data provide no support at all for Cournot models of industrial structure and pricing.

The answer to the second question is no. Even though sales were almost always by a single seller, monopolistic pricing did not emerge. Instead, the single seller sold at prices near those that would prevail if units were supplied at the lowest average cost that covered the opportunity cost of the supplying firm. The supplying firm chose to operate at a scale of plant and at prices such that consumers paid the lowest possible price subject to the constraint that the supplier did not make a loss. Briefly put, the system behavior was closer to that described by contestable market theory than any of the other models considered.

In some respects the data here provide strong support for the conclusions drawn from other studies that experimentally examined the possibility of contestability theory. One could have been concerned that the results of other studies might have been due to subject boredom, the linearity of costs, the lack of latitude for monopolistically competitive organizations, etc. The results of this paper demonstrate that such concern about previous results are not well founded. The fundamental tendencies reported by others were observed after all of the potential explanations were controlled.

To the extent that contestable market theory fell short of accurate predictions, the nature of the failure of contestability theory is interesting. The tendency to enter the "monopolized" market is too great and there is a chance that no one will enter. Firms tended to enter the industry in the hope that the incumbent would try to raise prices to near monopoly levels. Given the behavior of the incumbent, these firms would have been better off participating in alternative economic activity. In a sense, the policing activity was the cost of regulating the incumbent. Aside from this monitoring cost the system worked substantially as predicted by contestability theory.

Obviously, there exist many alternative ways to conduct experiments and check the robustness of the results reported here. Existing theory, especially game theory, is rich with suggestions for further experiments (Shapiro, 1989). Theoretically, the timing of decisions could switch market behavior between Bertrand and Cournot. Theories of signaling, repeated games and other facets of dynamic rivalry suggest variables and circumstances that might have dramatic effects on behavior. The message at this point seems to be that future research and experimental designs to explore these many possibilities should proceed on the presumption that contestability theory will have considerable exploratory power.

APPENDIX A

Tables Giving the Rotation of Market B Incentive Schedules for Demanders

Table A1: Rotation of Buyer Schedules

Experiment: 061191

	Buyer ID Number						
Period	00	01	02	03	04	05	06
1	S6	S7	S2	S1	S3	S4	S5
2	S7	S2	S1	S3	S4	S5	S6
3	S2	S1	S3	S4	S5	S6	S7
4	S1	S3	S4	S5	S6	S7	S2
5	S3	S4	S5	S6	S7	S2	S1
6	S4	S5	S6	S7	S2	S1	S3
7	S5	S6	S7	S2	S1	S3	S4
8	S6	S7	S2	S1	S3	S4	S5
9	S7	S2	S1	S3	S4	S5	S6
10	S2	S1	S3	S4	S5	S6	S7
11	S1	S3	S4	S5	S6	S7	S2
12	S3	S4	S5	S6	S7	S2	S1
13	S4	S5	S6	S7	S2	S1	S3
14	S5	S6	S7	S2	S1	S3	S4
15	S6	S7	S2	S1	S3	S4	S5
16	S7	S2	S1	S3	S4	S5	S6
17	S2	S1	S3	S4	S5	S6	S7
18	S1	S3	S4	S5	S6	S7	S2
19	S3	S4	S5	S6	S7	S2	S1

Note: For explanation of schedule notation see Table 2.

Table A2: Rotation of Buyer Schedules

Experiment: 062791

	Buyer ID Number						
Period	00	01	02	03	04	05	06
1	S6	S7	S2	S1	S3	S4	S5
2	S7	S2	S1	S3	S4	S5	S6
3	S2	S1	S3	S4	S5	S6	S7
4	S1	S3	S4	S5	S6	S7	S2
5	S3	S4	S5	S6	S7	S2	S1
6	S4	S5	S6	S7	S2	S1	S3
7	S5	S6	S7	S2	S1	S3	S4
8	S6	S7	S2	S1	S3	S4	S5
9	S7	S2	S1	S3	S4	S5	S6
10	S2	S1	S3	S4	S5	S6	S7
11	S1	S3	S4	S5	S6	S7	S2
12	S3	S4	S5	S6	S7	S2	S1
13	S4	S5	S6	S7	S2	S1	S3
14	S5	S6	S7	S2	S1	S3	S4
15	S6	S7	S2	S1	S3	S4	S5
16	S7	S2	S1	S3	S4	S5	S6
17	S2	S1	S3	S4	S5	S6	S7
18	S1	S3	S4	S5	S6	S7	S2
19	S3	S4	S5	S6	S7	S2	S1

Note: For explanation of schedule notation see Table 2.

Table A3: Rotation of Buyer Schedules

Experiment: 071991

	Buyer ID Number						
Period	00	01	02	03	04	05	06
1	S1	S2	S3	S4	S5	S6	S7
2	S3	S1	S4	S5	S6	S7	S2
3	S4	S5	S3	S1	S2	S7	S6
4	S5	S6	S4	S3	S1	S2	S7
5	S6	S7	S6	S4	S3	S1	S2
6	S7	S2	S6	S5	S4	S3	S1
7	S2	S1	S7	S6	S5	S4	S3
8	S1	S3	S2	S7	S6	S5	S4
9	S3	S4	S1	S2	S7	S6	S5
10	S4	S5	S3	S1	S2	S7	S6
11	S5	S6	S4	S3	S1	S2	S7
12	S6	S7	S5	S4	S3	S1	S2
13	S7	S2	S6	S5	S7	S3	S1
14	S2	S1	S7	S6	S5	S4	S3
15	S1	S3	S2	S7	S6	S5	S4
16	S3	S4	S1	S2	S7	S6	S5
17	S4	S5	S3	S1	S2	S7	S6
18	S5	S6	S4	S3	S1	S2	S7
19	S6	S7	S5	S4	S3	S1	S2

Note: For explanation of schedule notation see Table 2.

APPENDIX B

Instructions

GENERAL

This is an experiment in the economics of market decision making. The instructions are simple and if you follow them and make good decisions you might earn money which will be paid to you in cash.

In this experiment we are going to conduct two markets in which some of you will be buyers and some of you will be sellers in a sequence of market days or trading periods. Attached to the instructions you will find a sheet labeled Buyer or Seller, which describes the value to you of any decisions you might make. ***You are not to reveal this information to anyone.*** It is your own private information.

The Currency in this market is francs. Each franc is worth _____ dollars to you.

MARKET ORGANIZATION

There are two markets in this experiment, Market A and Market B.

1. Sellers may only trade in ***one*** market per trading period, either Market A ***or*** Market B. Before the markets open, Sellers must decide which market to enter.

2. Buyers are free to purchase from any seller or sellers in ***both*** Market A ***and*** Market B.

Market A is organized as follows.

Market A is a double auction. The trading period is open for _____ minutes. You should be familiar with how bids and asks are placed in the computer market.

Market B is organized as follows.

Market B is a posted price auction. The trading period is open for _____ minutes. The sellers place "sealed" asks in the beginning of the period. Sellers can not change their asks after placing their initial ask. Buyers in Market B can not place bids. Buyers can only accept an ask in order to make a purchase.

Both Market A and Market B will be open for the same length of time. Both markets will open simultaneously.

SPECIFIC INSTRUCTIONS TO SELLERS

During each trading period you may only trade in only ***one*** of the two markets. You are free to sell to any buyer or buyers as many units as you might want in the market you choose.

Market A and Market B are different. In Market A, the costs of the units depends only on the number of units you sell. In Market B, your costs are determined by both your choice of a schedule of production and the number of units you sell. The different schedules of production produce different unit costs. If you choose to enter Market B during a trading period, you must choose a production schedule and thereby your unit costs.

Since Market B is a posted price auction, sellers will have ***one*** opportunity to submit an ask. All asks are due at the beginning of the period. Market B sellers must therefore decide what production schedule to choose and how many units to offer for sale and at what price before the period starts. The asks for Market B will be submitted simultaneously so, at the time of decision no seller will know the decisions of any other seller. All Market B sellers will be instructed to enter their asks in the red order box and press 'F2' at the same time. Each seller must place their ask in the row in which they have inventory to sell. Sellers can only sell units where they have inventory available. The sellers in Market B, after pressing 'F2', will have one opportunity to cancel their asks if they wish to do so. If any seller decides to cancel their ask after submitting it, that seller can not enter Market A. Buyers will not be able to purchase units from Market B until anyone who wishes to cancel has done so. Similar to the submission of asks, any cancels will be done simultaneously, so no other seller will know the decisions of any other seller.

Procedure for Sellers:

1. Before the market opens, you must decide which market to enter, Market A or Market B.

2. After deciding which market to enter, you cross out the record area for the other market.

3. If you wish to enter Market B, you must
   a) choose a production schedule
   b) write your ask (both price and quantity) on your record sheet in the space provided.
   c) then input your ask (price and quantity) in the red order box on the computer.

4. When the markets open, all sellers in Market B must press the 'F2' key at the second when the experimenter indicates.

5. Sellers wishing to cancel their asks will be able to do so when the experimenter indicates.

Suppose you choose to enter Market A. The first unit that you sell in Market A in the indicated trading period, you obtain at a cost of the amount listed on the attached record sheets for the first unit. If you sell a second unit during the same trading period you incur the additional cost of the second unit. The profits from each sale (which are yours to keep) are computed by taking the difference between the price at which you sold the unit and the cost of the unit. That is

Your Unit Profit = Sale Price of Unit - Cost of Unit

Suppose you choose to enter Market A and sold 2 units. Your selling prices were 200 for the first unit and 190 for the second unit. If your cost for the first unit was 140 and for the second was 160, then your profits would be:

Sellers Market A Profit Calculation

Market A Profits

Profits From First Unit =	200 - 140	=	60
Profits From Second Unit =	190 - 160	=	30
Total Unit Profits =	60 + 30	=	90

Suppose, for example, that you enter Market B. Your costs in Market B are determined by the production schedule you choose before the trading period started. For the first unit that you sell, in the indicated trading period, you obtain at the cost of the amount listed under the column of your production schedule. If you sell a second unit during the same trading period you incur the cost of the second unit listed under the production schedule you have chosen, etc. The profits from the trading period (which are yours to keep) are computed by taking the difference between the price at which you sold the unit and the cost of the unit. That is,

Your Unit Profit = Sale Price of Unit - Cost of Unit

Suppose, for example, you choose a production schedule such that your cost for the first unit is 50 and for the second unit it is 75. If you sell both units at the price of 200 francs, then your profits are:

Sellers Market B Profit Calculation

Total Unit Profits

Profit from First Unit =	200 - 50	=	150
Profit from Second Unit =	200 - 75	=	125
Total Unit Profit =	150 + 125	=	275

The blanks on the table will help you record your profits. The sale price of the each unit you buy should be recorded at the time of sale. At the end of the period, record total of profits on the bottom of the page. Subsequent periods should be recorded similarly.

A total cost sheet and average cost sheet have also been included. A summary profit sheet has also been provided. After you are familiar with the accounting you may want to use it.

SPECIFIC INSTRUCTIONS TO BUYERS

During each trading period you are free to purchase from any seller or sellers as many units as you might want and from any market you might want. For the first unit that you buy in either Market A or B, you will receive the amount listed as the first redemption value under unit 1 for either Market A or Market B. If you buy a second unit during the same trading period in the same market, you will receive the additional amount listed as the 2nd Unit Redemption Value, etc. The profits from each purchase (which are yours to keep) are computed by taking the difference between the redemption value and purchase price of the unit bought. That is

Your Profits = Redemption Value - Purchase Price

Suppose, for example, that you bought two units in Market A and your redemption value for the first unit is 200 and for the second is 180. In addition, suppose in Market B, you purchased two units and your redemption value for the first unit of Market B is 140 and for the second is 130. If you paid 150 for the first unit in Market A and 160 for the second unit in Market A and you paid 100 for the first unit in Market B and 90 for the second unit in Market B, then your profits are:

Buyer Profit Calculation

Market A Profits

Profits From First Unit =	200 - 150	=	50
Profits From Second Unit =	180 - 160	=	20
Total Unit Profits =	50 + 20	=	70

Market B Profits

Profits From First Unit =	140 -100	=	40
Profits From Second Unit =	130 - 90	=	40
Total Unit Profits =	40 + 40	=	80

Total Period Profits

Mrkt A + Mkt B Unit Profits =	70 + 80	=	150

The blanks on the table will help you record your profits. The sale price of the each unit you buy should be recorded at the time of sale. At the end of the period, record total of profits on the bottom of the page. Subsequent periods should be recorded similarly.

Special Information to All Sellers

The following table is an approximation of the market demand function. That is, if the price is maintained at some level, the purchasers are able to profitably purchase as many units as described by the demand table. The model says nothing as to how this volume may be distributed among the sellers.

Market Price	Quantity Demanded
1076 or More	0
1051 to 1075	1
1026 to 1050	2
1001 to 1025	3
976 to 1000	4
951 to 975	5
926 to 950	6
901 to 925	7
876 to 900	8
851 to 875	9
826 to 850	10
801 to 825	11
776 to 800	12
751 to 775	13
726 to 750	14
701 to 725	15
676 to 700	16
651 to 675	17
626 to 650	18
601 to 625	19
576 to 600	20
551 to 575	21
526 to 550	22
501 to 525	23
476 to 500	24
451 to 475	25
426 to 450	26
401 to 425	27
376 to 400	28
351 to 375	29
326 to 350	30
301 to 325	31
276 to 300	32
251 to 275	33
226 to 250	34
201 to 225	35
176 to 200	36
151 to 175	37
126 to 150	38
101 to 125	39
76 to 100	40
etc	etc

SELLERS' PRACTICE COST SHEET

UNIT COSTS (cost of additional unit)

		Production Schedule Choice ---------->																								
		...	...	...	...	...	...	...	...	...	J	K	L	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Units	14	...	...	...	...	...	...	...	...	...	250	300	320	...	...	...	...	...	...	...	...	...	...	...	...	...
Sold	15	...	...	...	...	...	...	...	...	...	230	280	300	...	...	...	...	...	...	...	...	...	...	...	...	...
I	16	...	...	...	...	...	...	...	...	...	200	300	250	...	...	...	...	...	...	...	...	...	...	...	...	...
I	17	...	...	...	...	...	...	...	...	...	200	320	270	...	...	...	...	...	...	...	...	...	...	...	...	...
V	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

AVERAGE COSTS (cost per unit sold)

		Production Schedule Choice ----->																								
		...	...	...	...	...	...	...	...	...	J	K	L	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Units	14	...	...	...	...	...	...	...	...	...	214	200	188	...	...	...	...	...	...	...	...	...	...	...	...	...
Sold	15	...	...	...	...	...	...	...	...	...	215	205	193	...	...	...	...	...	...	...	...	...	...	...	...	...
I	16	...	...	...	...	...	...	...	...	...	214	211	197	...	...	...	...	...	...	...	...	...	...	...	...	...
I	17	...	...	...	...	...	...	...	...	...	215	216	201	...	...	...	...	...	...	...	...	...	...	...	...	...
V	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

CUMULATIVE or TOTAL COSTS

		Production Schedule Choice ---------->																								
		...	...	...	...	...	...	...	...	...	J	K	L	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Units	14	...	...	...	...	...	...	...	...	...	3000	2800	2800	...	...	...	...	...	...	...	...	...	...	...	...	...
Sold	15	...	...	...	...	...	...	...	...	...	3230	3080	2900	...	...	...	...	...	...	...	...	...	...	...	...	...
I	16	...	...	...	...	...	...	...	...	...	3430	3380	3150	...	...	...	...	...	...	...	...	...	...	...	...	...
I	17	...	...	...	...	...	...	...	...	...	3660	3700	3420	...	...	...	...	...	...	...	...	...	...	...	...	...
V	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Seller I.D.#_____

Period # _____

Practice Sheet

Seller - Market A

Seller - Market B

Unit #	[x] Selling Price	[y] Unit Cost	[x]-[y] Unit Profit
1		50	
2		150	
3		150	
4		300	
5		400	
6		500	
7		600	
8		700	
9		800	
10		800	
11		800	
12		800	
13		800	
14		800	
15		800	
16		800	
17		800	
18		800	
19		800	
20		800	
21		800	
22		800	
23		800	
24		800	
25		800	
Total Unit Profits			

Fill the top section out before the period begins.

A.	Production Schedule	K
B.	Posted Price	430
C.	Quantity Offered	16

D.	Posted Price	(B)	
E.	Quantity Sold		15
F.	Revenue	(D*E)	
G.	Total Cost	(Cum.Cost Sheet)	
H.	Profit	(F-G)	

Seller I.D.#_____

Period # _____

Seller - Market A

Seller - Market B

Unit #	[x] Selling Price	[y] Unit Cost	[x]-[y] Unit Profit
1		550	
2		550	
3		700	
4		700	
5		700	
6		700	
7		700	
8		700	
9		700	
10		700	
11		700	
12		700	
13		700	
14		700	
15		700	
16		700	
17		700	
18		700	
19		700	
20		700	
21		700	
22		700	
23		700	
24		700	
25		700	
	Total Unit Profits		

Fill the top section out before the period begins.

A. Production Schedule

B. Posted Price

C. Quantity Offered

D. Posted Price (B)

E. Quantity Sold

F. Revenue (D*E)

G. Total Cost (Cum.Cost Sheet)

H. Profit (F-G)

UNIT COSTS (cost of additional unit)

PERIOD # _____

Production Schedule Choice ---------->

Total Units Sold		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
	1	505	507	590	596	603	613	624	638	653	671	690	712	735	761	788	818	849	883	918	956	995	1037	1080	1126	1173
	2	557	555	556	558	563	569	578	588	601	615	632	650	671	693	718	744	773	803	836	870	907	945	986	1028	1073
	3	533	528	526	525	527	530	536	543	553	564	578	593	611	630	652	675	701	728	758	789	823	858	896	935	977
	4	513	506	500	497	495	496	498	503	509	518	528	541	555	572	590	611	633	658	684	713	743	776	810	847	885
|	5	498	488	479	473	468	466	465	467	470	476	483	493	504	518	533	551	570	592	615	641	668	698	729	763	798
|	6	488	474	463	453	446	440	437	435	436	438	443	449	458	468	481	495	512	530	551	573	598	624	653	683	716
|	7	482	465	451	438	428	419	413	408	406	405	407	410	416	423	433	444	458	473	491	510	532	555	581	608	638
|	8	480	461	443	428	414	403	393	386	380	377	375	376	378	383	389	398	408	421	435	452	470	491	513	538	564
V	9	483	461	440	422	405	391	378	368	359	353	348	346	345	347	350	356	363	373	384	398	413	431	450	472	495
	10	491	465	442	420	401	383	368	354	343	333	326	320	317	315	316	318	323	329	338	348	361	375	392	410	431
	11	503	474	448	423	401	380	362	345	331	318	308	299	293	288	286	285	287	290	296	303	313	324	338	353	371
	12	519	488	458	431	405	382	360	341	323	308	294	283	273	266	260	257	255	256	258	263	269	278	288	301	315
	13	540	506	473	443	414	388	363	341	320	302	285	271	258	248	239	233	228	226	225	227	230	236	243	253	264
	14	566	528	493	459	428	398	371	345	322	300	281	263	248	234	223	213	206	200	197	195	196	198	203	209	218
	15	596	555	517	480	446	413	383	354	328	303	281	260	242	225	211	198	188	179	173	168	166	165	167	170	176
	16	630	587	545	506	468	433	399	368	338	311	285	262	240	221	203	188	174	163	153	146	140	137	135	136	138
	17	669	623	578	536	495	457	420	386	353	323	294	268	243	221	200	182	165	151	138	128	119	113	108	106	105
	18	713	663	616	570	527	485	446	408	373	339	308	278	251	225	202	180	161	143	128	114	103	93	86	80	77
	19	761	708	658	609	563	518	476	435	397	360	326	293	263	234	208	183	161	140	122	105	91	78	68	59	53
	20	813	758	704	653	603	556	510	467	425	386	348	313	279	248	218	191	165	142	120	101	83	68	54	43	33
	21	870	812	755	701	648	598	549	503	458	416	375	337	300	266	233	203	174	148	123	101	80	62	45	31	18
	22	932	870	811	753	698	644	593	543	496	450	407	365	326	288	253	219	188	158	131	105	82	60	41	23	8
	23	998	933	871	810	752	695	641	588	538	489	443	398	356	315	277	240	206	173	143	114	88	63	41	20	2
	24	1068	1001	935	872	810	751	693	638	584	533	483	436	390	347	305	266	228	193	159	128	98	71	45	22	0
	25	1143	1073	1004	938	873	811	750	692	635	581	528	478	429	383	338	296	255	217	180	146	113	83	54	28	3
	26	1223	1149	1078	1008	941	875	812	750	691	633	578	524	473	423	376	330	287	245	206	168	133	99	68	38	11
	27	1307	1230	1156	1083	1013	944	878	813	751	690	632	575	521	468	418	369	323	278	236	195	157	120	86	53	23
	28	1395	1316	1238	1163	1089	1018	948	881	815	752	690	631	573	518	464	413	363	316	270	227	185	146	108	73	39
	29	1488	1406	1325	1247	1170	1096	1023	953	884	818	753	691	630	572	515	461	408	358	309	263	218	176	135	97	60
	30	1586	1500	1417	1335	1256	1178	1103	1029	958	888	821	755	692	630	571	513	458	404	353	303	256	210	167	125	86
	31	1688	1599	1513	1428	1346	1265	1187	1110	1036	963	893	824	758	693	631	570	512	455	401	348	298	249	203	158	116
	32	1794	1703	1613	1526	1440	1357	1275	1196	1118	1043	969	898	828	761	695	632	570	511	453	398	344	293	243	196	150
	33	1905	1811	1718	1628	1539	1453	1368	1286	1205	1127	1050	976	903	833	764	698	633	571	510	452	395	341	288	238	189
	34	2021	1923	1828	1734	1643	1553	1466	1380	1297	1215	1136	1058	983	909	838	768	701	635	572	510	451	393	338	284	233
	35	2141	2040	1942	1845	1751	1658	1568	1479	1393	1308	1226	1145	1067	990	916	843	773	704	638	573	511	450	392	335	281
	36	2265	2162	2060	1961	1863	1768	1674	1583	1493	1406	1320	1237	1155	1076	998	923	849	778	708	641	575	512	450	391	333
	37	2394	2288	2183	2081	1980	1882	1785	1691	1598	1508	1419	1333	1248	1166	1085	1007	930	856	783	713	644	578	513	451	390
	38	2528	2418	2311	2205	2102	2000	1901	1803	1708	1614	1523	1433	1346	1260	1177	1095	1016	938	863	789	718	648	581	515	452
	39	2666	2553	2443	2334	2228	2123	2021	1920	1822	1725	1631	1536	1446	1359	1273	1188	1106	1025	947	870	796	723	653	584	518
	40	2808	2693	2579	2468	2358	2251	2145	2042	1940	1841	1743	1648	1554	1463	1373	1286	1200	1117	1035	956	878	803	729	658	588

AVERAGE COSTS (cost per unit sold)

Total Units Sold	Production Schedule Choice ----> A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	585	587	590	596	603	613	624	638	653	671	690	712	735	761	788	818	849	883	918	956	995	1037	1080	1126	1173
2	571	571	573	577	583	591	601	613	627	643	661	681	703	727	753	781	811	843	877	913	951	991	1033	1077	1123
3	558	557	557	560	564	571	579	590	602	617	633	652	672	695	719	746	774	805	837	872	908	947	987	1030	1074
4	547	544	543	544	547	552	559	568	579	592	607	624	643	664	687	712	739	768	799	832	867	904	943	984	1027
5	537	533	530	530	531	535	540	548	557	569	582	598	615	635	656	680	705	733	762	794	827	863	900	940	981
6	529	523	519	517	517	519	523	529	537	547	559	573	589	607	627	649	673	699	727	757	789	823	859	897	937
7	522	515	509	506	504	505	507	512	518	527	537	550	564	581	599	620	642	667	693	722	752	785	819	856	894
8	517	508	501	498	493	492	493	496	501	508	517	528	541	556	573	592	613	636	661	688	717	748	781	816	853
9	513	503	494	488	483	481	480	482	485	491	498	508	519	533	548	566	585	607	630	656	683	713	744	778	813
10	511	499	489	481	475	471	469	469	471	475	481	489	499	511	525	541	559	579	601	625	651	679	709	741	775
11	510	497	485	476	468	463	459	458	458	461	465	472	480	491	503	518	534	553	573	596	620	647	675	706	738
12	511	496	483	472	463	456	451	448	447	446	451	456	463	472	483	496	511	528	547	568	591	616	643	672	703
13	513	497	482	470	459	451	444	440	437	437	438	442	447	455	464	476	489	505	522	542	563	587	612	640	669
14	517	499	483	469	457	447	439	433	429	427	427	429	433	439	447	457	469	483	499	517	537	559	583	609	637
15	522	503	485	470	456	445	435	428	422	419	417	418	420	425	431	440	450	463	477	494	512	533	555	580	606
16	529	508	489	472	457	444	433	424	417	412	409	408	409	412	417	424	433	444	457	472	489	508	529	552	577
17	537	515	494	476	459	445	432	422	413	407	402	400	399	401	404	410	417	427	438	452	467	485	504	526	549
18	547	523	501	481	463	447	433	421	411	403	397	393	391	391	393	397	403	411	421	433	447	463	481	501	523
19	558	533	509	488	468	451	435	422	410	401	393	388	384	383	383	386	390	397	405	416	428	443	459	478	498
20	571	544	519	496	475	456	439	424	411	400	391	384	379	376	375	376	379	384	391	400	411	424	439	456	475
21	585	557	530	506	483	463	444	428	413	401	390	382	375	371	368	368	369	373	378	386	395	407	420	436	453
22	601	571	543	517	493	471	451	433	417	403	391	381	373	367	363	361	361	363	367	373	381	391	403	417	433
23	618	587	557	530	504	481	459	440	422	407	393	382	372	365	359	356	354	355	357	362	368	377	387	400	414
24	637	604	573	544	517	492	469	448	429	412	397	384	373	364	357	352	349	348	349	352	357	364	373	384	397
25	657	623	590	560	531	505	480	458	437	419	402	388	375	365	356	350	345	343	342	344	347	353	360	370	381
26	679	643	609	577	547	519	493	469	447	427	409	393	379	367	357	349	343	339	337	337	339	343	349	357	367
27	702	665	629	596	564	535	507	482	458	437	417	400	384	371	359	350	342	337	333	332	332	335	339	346	354
28	727	688	651	616	583	552	523	496	471	448	427	408	391	378	363	352	343	336	331	328	327	328	331	336	343
29	753	713	674	638	603	571	540	512	485	461	438	418	399	383	368	356	345	337	330	326	323	323	324	328	333
30	781	739	699	661	625	591	559	529	501	475	451	429	409	391	375	361	349	339	331	325	321	319	319	321	325
31	810	767	725	686	648	613	579	548	518	491	465	442	420	401	383	368	354	343	333	326	320	317	315	316	318
32	841	796	753	712	673	636	601	568	537	508	481	456	433	412	393	376	361	348	337	328	321	316	313	312	313
33	873	827	782	740	699	661	624	590	557	527	498	472	447	425	404	386	369	355	342	332	323	317	312	310	309
34	907	859	813	769	727	687	649	613	579	547	517	489	463	439	417	397	379	363	349	337	327	319	313	309	307
35	942	893	845	800	756	715	675	638	602	569	537	508	480	455	431	410	390	373	357	344	332	323	315	310	306
36	979	928	879	832	787	744	703	664	627	592	559	528	499	472	447	424	403	384	367	352	339	328	319	312	307
37	1017	965	914	866	819	775	732	692	653	617	582	550	519	491	464	440	417	397	378	362	347	335	324	316	309
38	1057	1003	951	901	853	807	763	721	681	643	607	573	541	511	483	457	433	411	391	373	357	343	331	321	313
39	1098	1043	989	938	888	841	795	752	710	671	633	598	564	533	503	476	450	427	405	386	368	353	339	328	318
40	1141	1084	1029	978	925	876	829	784	741	700	661	624	589	556	525	496	469	444	421	400	381	364	349	336	325

CUMULATIVE or TOTAL COSTS

		Production Schedule Choice ---------->																							
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Total	1	585	587	590	596	603	613	624	638	653	671	690	712	735	761	788	818	849	883	918	956	995	1037	1080	1126	1173
Units	2	1142	1142	1146	1154	1166	1182	1202	1226	1254	1286	1322	1362	1406	1454	1506	1562	1622	1686	1754	1826	1902	1982	2066	2154	2246
Sold	3	1675	1670	1672	1679	1693	1712	1738	1769	1807	1850	1900	1955	2017	2084	2158	2237	2323	2414	2512	2615	2725	2840	2962	3089	3223
	4	2188	2176	2172	2176	2188	2208	2236	2272	2316	2368	2428	2496	2572	2656	2748	2848	2956	3072	3196	3328	3468	3616	3772	3936	4108
I	5	2686	2664	2651	2649	2656	2674	2701	2739	2786	2844	2911	2989	3076	3174	3281	3399	3526	3664	3811	3969	4136	4314	4501	4699	4906
I	6	3174	3138	3114	3102	3102	3114	3138	3174	3222	3282	3354	3438	3534	3642	3762	3894	4038	4194	4362	4542	4734	4938	5154	5382	5622
I	7	3656	3603	3565	3540	3530	3533	3551	3582	3628	3687	3761	3848	3950	4065	4195	4338	4496	4667	4853	5052	5266	5493	5735	5990	6260
I	8	4136	4064	4008	3968	3944	3936	3944	3968	4008	4064	4136	4224	4328	4448	4584	4736	4904	5088	5288	5504	5736	5984	6248	6528	6824
V	9	4619	4525	4448	4390	4349	4327	4322	4336	4367	4417	4484	4570	4673	4795	4934	5092	5267	5461	5672	5902	6149	6415	6698	7000	7319
	10	5110	4990	4890	4810	4750	4710	4690	4690	4710	4750	4810	4890	4990	5110	5250	5410	5590	5790	6010	6250	6510	6790	7090	7410	7750
	11	5613	5464	5338	5233	5151	5090	5052	5035	5041	5068	5118	5189	5283	5398	5536	5695	5877	6080	6306	6553	6823	7114	7428	7763	8121
	12	6132	5952	5796	5664	5556	5472	5412	5376	5384	5376	5412	5472	5556	5664	5796	5952	6132	6336	6564	6816	7092	7392	7716	8064	8436
	13	6672	6458	6269	8107	5970	5860	5775	5717	5684	5678	5697	5743	5814	5912	6035	6185	6360	6562	6789	7043	7322	7628	7959	8317	8700
	14	7238	6986	6762	6566	6398	6258	6146	6062	6006	5978	5978	6006	6062	6146	6258	6398	6566	6762	6986	7238	7518	7826	8162	8526	8918
	15	7834	7541	7279	7046	6844	6671	6529	6416	6334	6281	6259	6266	6304	6371	6469	6596	6754	6941	7159	7406	7684	7991	8329	8696	9094
	16	8464	8128	7824	7552	7312	7104	6928	6784	6672	6592	6544	6528	6544	6592	6672	6784	6928	7104	7312	7552	7824	8128	8464	8832	9232
	17	9133	8751	8402	8088	7807	7561	7348	7170	7025	6915	6838	6796	6787	6813	6872	6966	7093	7255	7450	7680	7943	8241	8572	8938	9337
	18	9846	9414	9018	8658	8334	8046	7794	7578	7398	7254	7146	7074	7038	7038	7074	7146	7254	7398	7578	7794	8046	8334	8658	9018	9414
	19	10607	10122	9676	9267	8897	8564	8270	8013	7795	7614	7472	7367	7301	7272	7282	7329	7415	7538	7700	7899	8137	8412	8726	9077	9467
	20	11420	10880	10380	9920	9500	9120	8780	8480	8220	8000	7820	7680	7580	7520	7500	7520	7580	7680	7820	8000	8220	8480	8780	9120	9500
	21	12290	11692	11135	10621	10148	9718	9329	8983	8678	8416	8195	8017	7880	7786	7733	7723	7754	7828	7943	8101	8300	8542	8825	9151	9518
	22	13222	12562	11946	11374	10846	10362	9922	9526	9174	8866	8602	8382	8206	8074	7986	7942	7942	7986	8074	8206	8382	8602	8866	9174	9526
	23	14220	13495	12817	12184	11598	11057	10563	10114	9712	9355	9045	8780	8562	8389	8263	8182	8148	8159	8217	8320	8470	8665	8907	9194	9528
	24	15288	14496	13752	13056	12408	11808	11256	10752	10296	9888	9528	9216	8952	8736	8568	8448	8376	8352	8376	8448	8568	8736	8952	9216	9528
	25	16431	15569	14756	13994	13281	12619	12006	11444	10931	10469	10056	9694	9381	9119	8906	8744	8631	8569	8556	8594	8681	8819	9006	9244	9531
	26	17654	16718	15834	15002	14222	13494	12818	12194	11622	11102	10634	10218	9854	9542	9282	9074	8918	8814	8762	8762	8814	8918	9074	9282	9542
	27	18961	17948	16990	16085	15235	14438	13696	13007	12373	11792	11266	10793	10375	10010	9700	9443	9241	9092	8998	8957	8971	9038	9160	9335	9565
	28	20356	19264	18228	17248	16324	15456	14644	13888	13188	12544	11956	11424	10948	10528	10164	9856	9604	9408	9268	9184	9156	9184	9268	9408	9604
	29	21844	20670	19553	18495	17494	16552	15667	14841	14072	13362	12709	12115	11578	11100	10679	10317	10012	9766	9577	9447	9374	9360	9403	9505	9664
	30	23430	22170	20970	19830	18750	17730	16770	15870	15030	14250	13530	12870	12270	11730	11250	10830	10470	10170	9930	9750	9630	9570	9570	9630	9750
	31	25116	23769	22483	21258	20096	18995	17957	16980	16066	15213	14423	13694	13026	12423	11881	11400	10982	10625	10331	10098	9928	9819	9773	9788	9866
	32	26912	25472	24096	22784	21536	20352	19232	18176	17184	16256	15392	14592	13856	13184	12576	12032	11552	11136	10784	10496	10272	10112	10016	9984	10016
	33	28817	27283	25814	24412	23075	21805	20600	19462	18389	17383	16442	15568	14759	14017	13340	12730	12185	11707	11294	10948	10667	10453	10304	10222	10205
	34	30838	29206	27642	26146	24718	23358	22066	20842	19686	18598	17578	16626	15742	14926	14178	13498	12886	12342	11866	11458	11118	10846	10642	10506	10438
	35	32979	31246	29584	27991	26469	25016	23634	22321	21079	19906	18804	17771	16809	15916	15094	14341	13659	13046	12504	12031	11629	11296	11034	10841	10719
	36	35244	33408	31644	29952	28332	26784	25308	23904	22572	21312	20124	19008	17964	16992	16092	15264	14508	13824	13212	12672	12204	11808	11484	11232	11052
	37	37638	35696	33827	32033	30312	28666	27093	25595	24170	22820	21543	20341	19212	18158	17177	16271	15438	14680	13995	13385	12848	12386	11997	11683	11442
	38	40166	38114	36138	34238	32414	30666	28994	27398	25878	24434	23066	21774	20558	19418	18354	17366	16454	15618	14858	14174	13566	13034	12578	12198	11894
	39	42832	40667	38581	36572	34642	32789	31015	29318	27700	26159	24697	23312	22006	20777	19627	18554	17560	16643	15805	15044	14362	13757	13231	12782	12412
	40	45640	43360	41160	39040	37000	35040	33160	31360	29640	28000	26440	24960	23560	22240	21000	19840	18760	17760	16840	16000	15240	14560	13960	13440	13000

Buyer's Practice Sheet

Buyer I.D.#____

Period # ____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	550		
2	400		
3	400		
4	200		
5	100		
6	0		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	500		
2	400		
3	300		
4	200		
5	100		
6	0		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Total Profits Worksheet

Name _____

ID# _____

Period #	Profit
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	

Total _____ Francs

Conversion Factor _____

Earnings _____ Dollars

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1085		
2	760		
3	735		
4	410		
5	385		
6	60		
7	35		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1060		
2	785		
3	710		
4	435		
5	360		
6	85		
7	10		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		
	Market A - Profits		

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1035		
2	810		
3	685		
4	460		
5	335		
6	110		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		
	Market B - Profits		

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1010		
2	835		
3	660		
4	485		
5	310		
6	135		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	985		
2	860		
3	635		
4	510		
5	285		
6	160		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	960		
2	885		
3	610		
4	535		
5	260		
6	185		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Buyer's Sheet

Buyer I.D.# _____

Period # _____

Market A

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	1000		
2	1000		
3	1000		
4	400		
5	400		
6	400		
7	400		
8	400		
9	400		
10	400		
11	400		
12	400		
13	400		
14	400		
15	400		

Market A - Profits

Market B

Unit #	[x] Redemption Value	[y] Purchase Price	[x]-[y] Unit Profit
1	935		
2	910		
3	585		
4	560		
5	235		
6	210		
7	0		
8	0		
9	0		
10	0		
11	0		
12	0		
13	0		
14	0		
15	0		

Market B - Profits

Total Profits

Figure 1

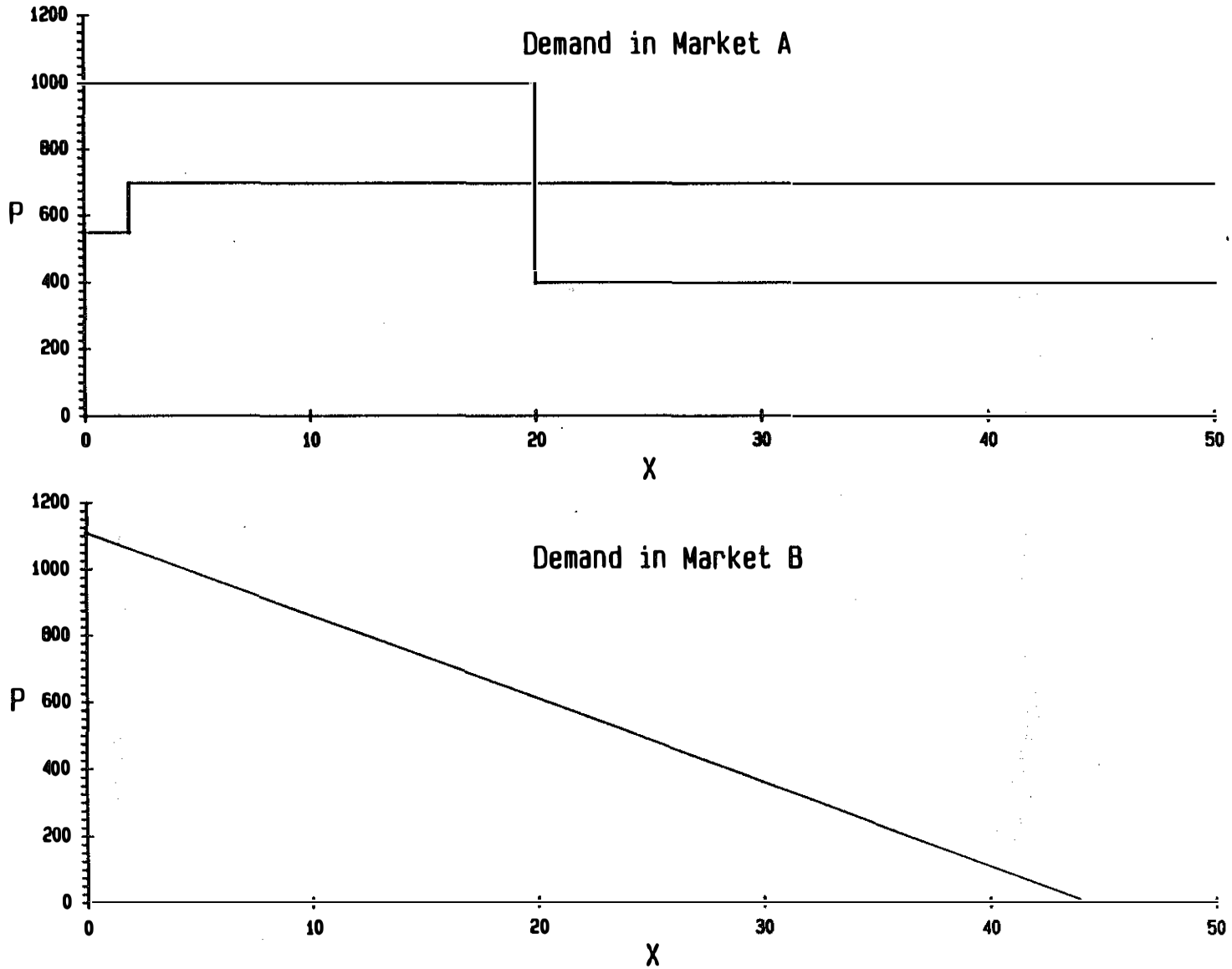
Demand in Market A
1200
1000
800
P 600
400
200
0
0
10
20
30
40
50
X
Demand in Market B
1200
1000
800
P 600
400
200
0
0
10
20
30
40
50
X

Figure 2

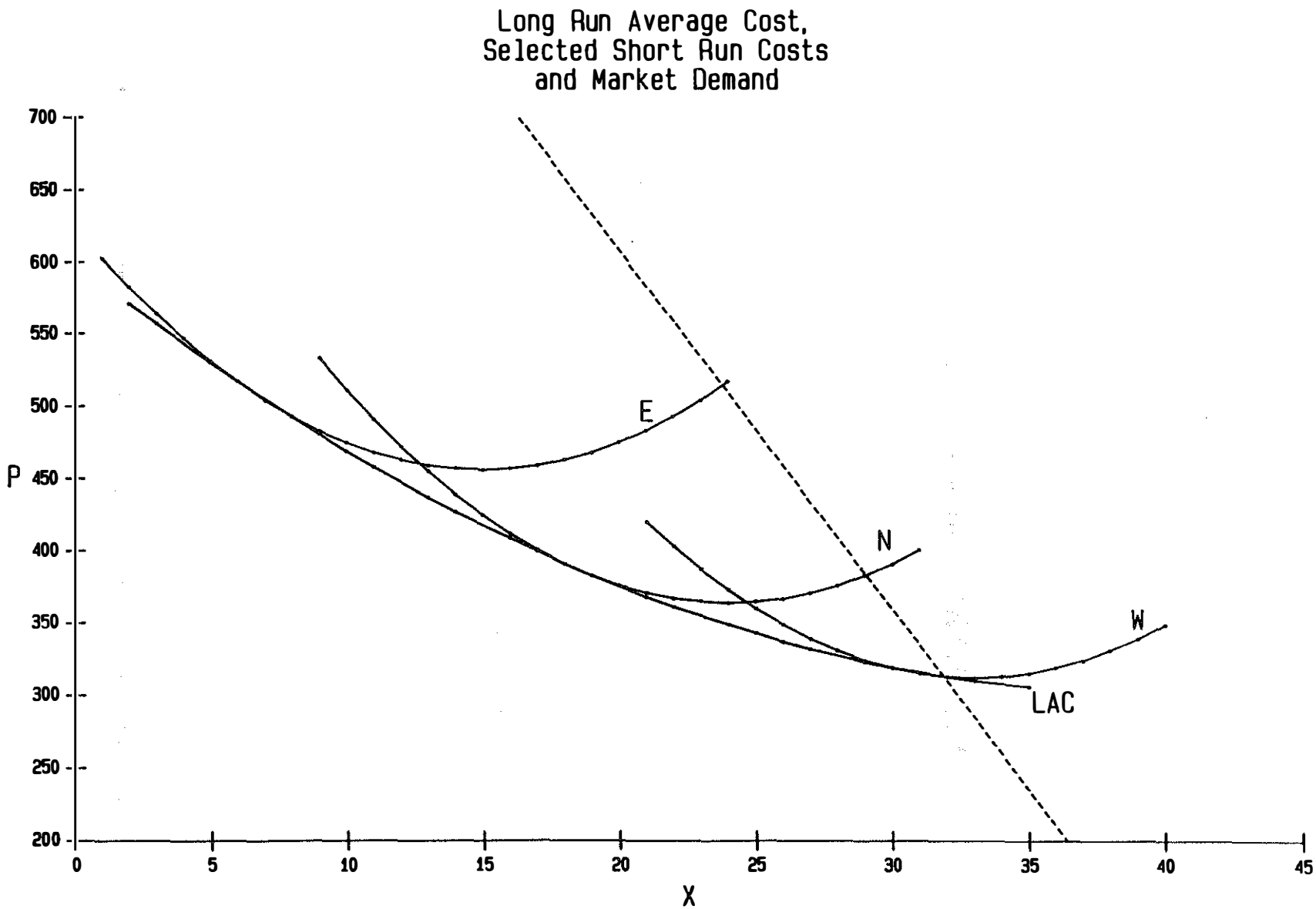
Long Run Average Cost,
Selected Short Run Costs
and Market Demand
700
650
600
550
500
450
400
350
300
250
200
P
0
5
10
15
20
25
30
35
40
45
X
E
N
W
LAC

Figure 3

Monopolist in Market B: A Continous Approximation

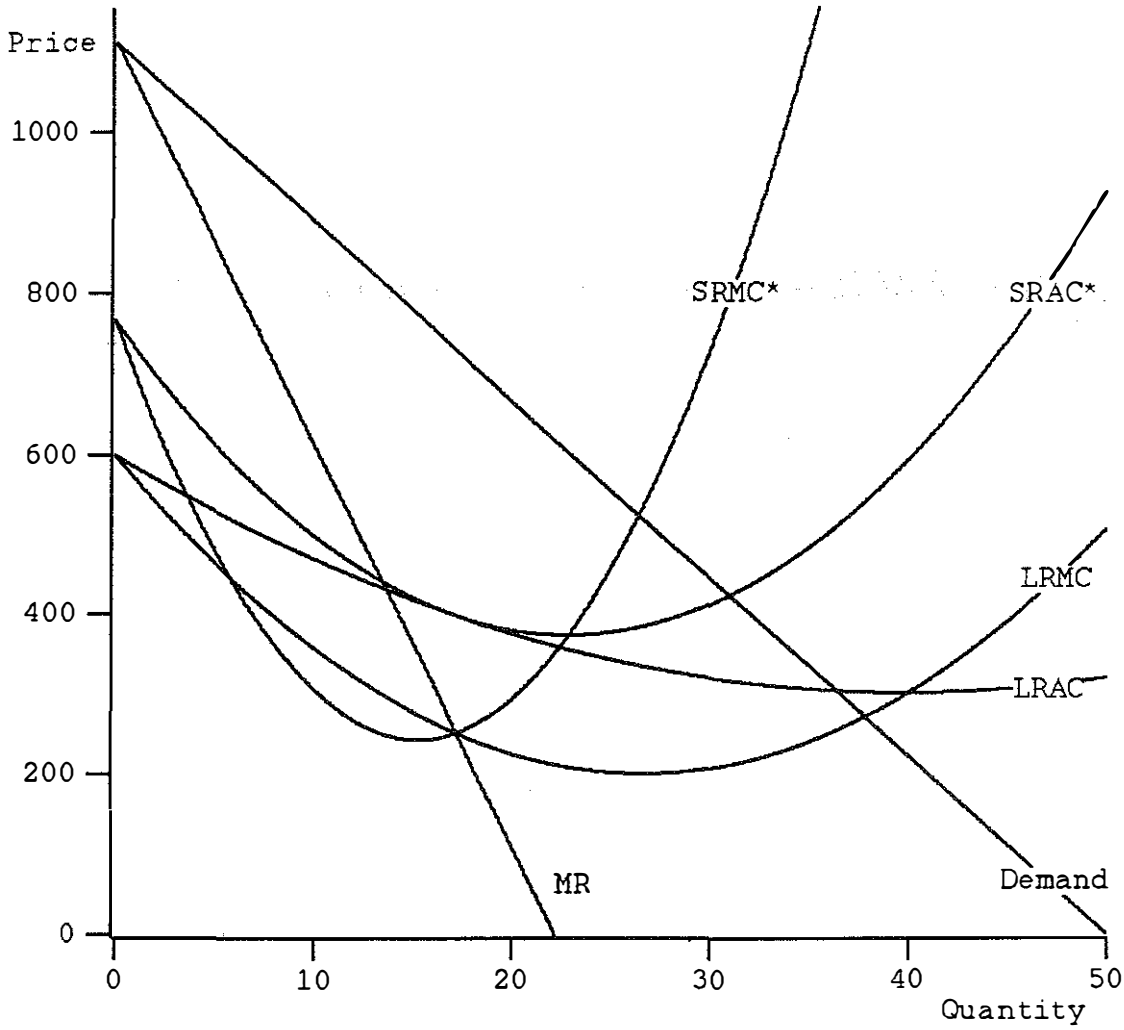

Figure 4

Quadopolist in Market B: A Continous Approximation

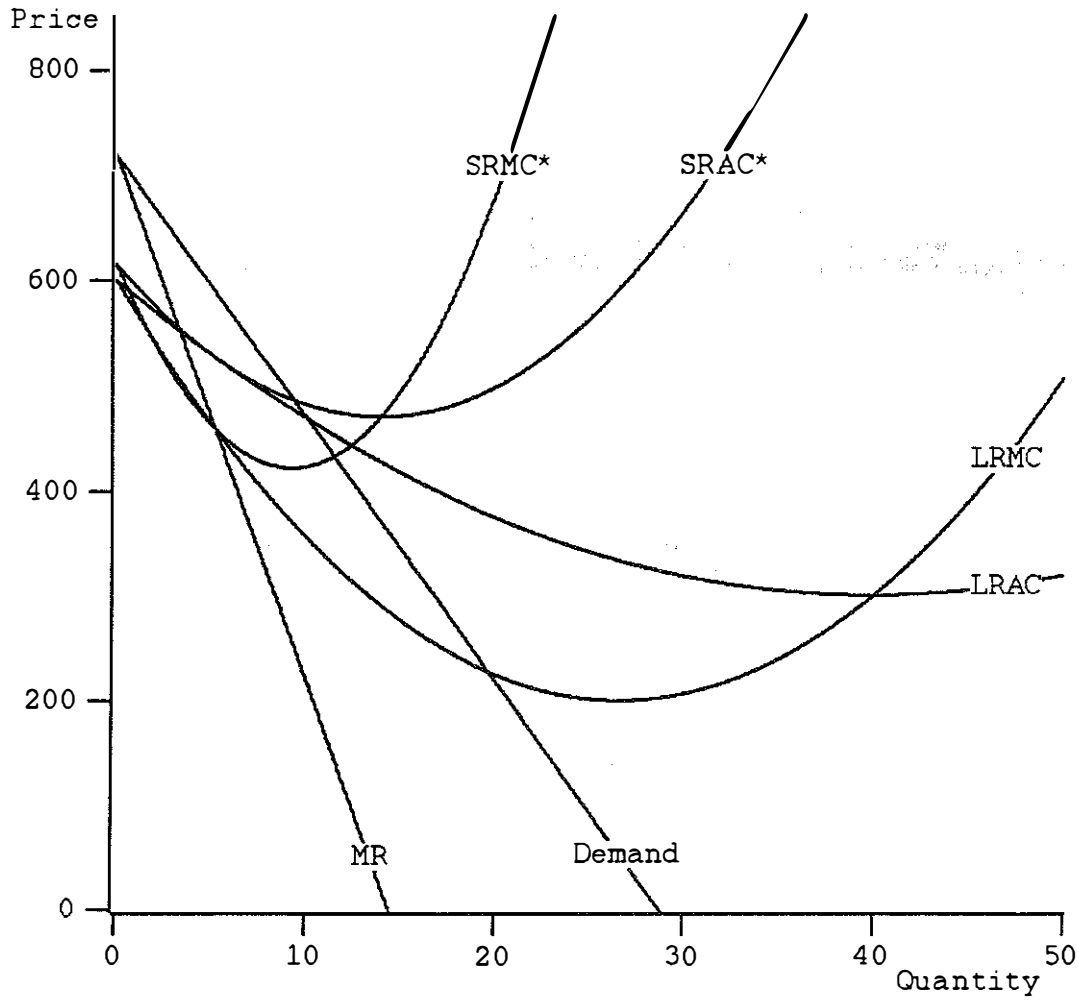

Figure 5: Market A, Price Time Series, Exp. 061191

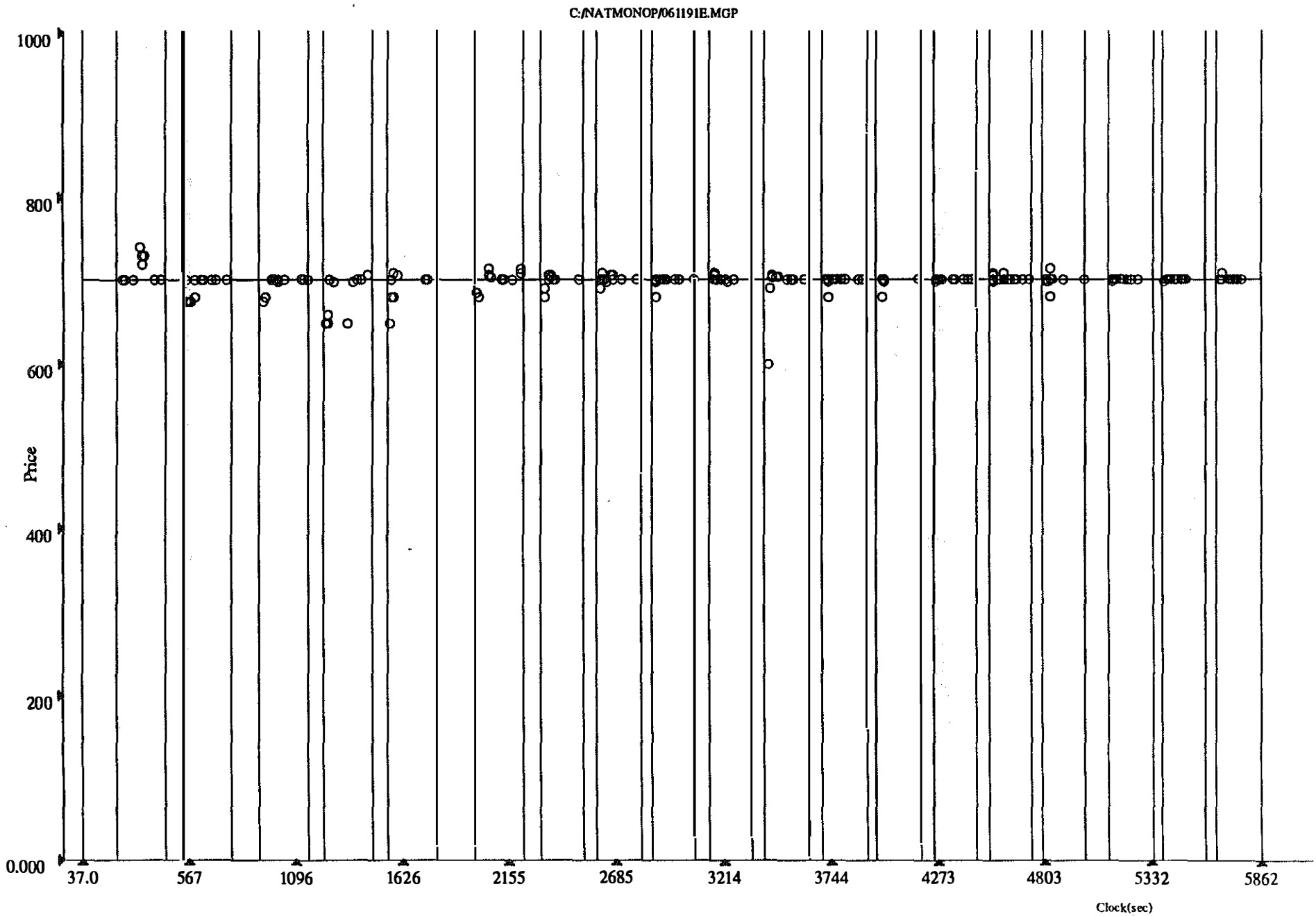

Figure 6: Market B, Price Time Series, Exp. 061191

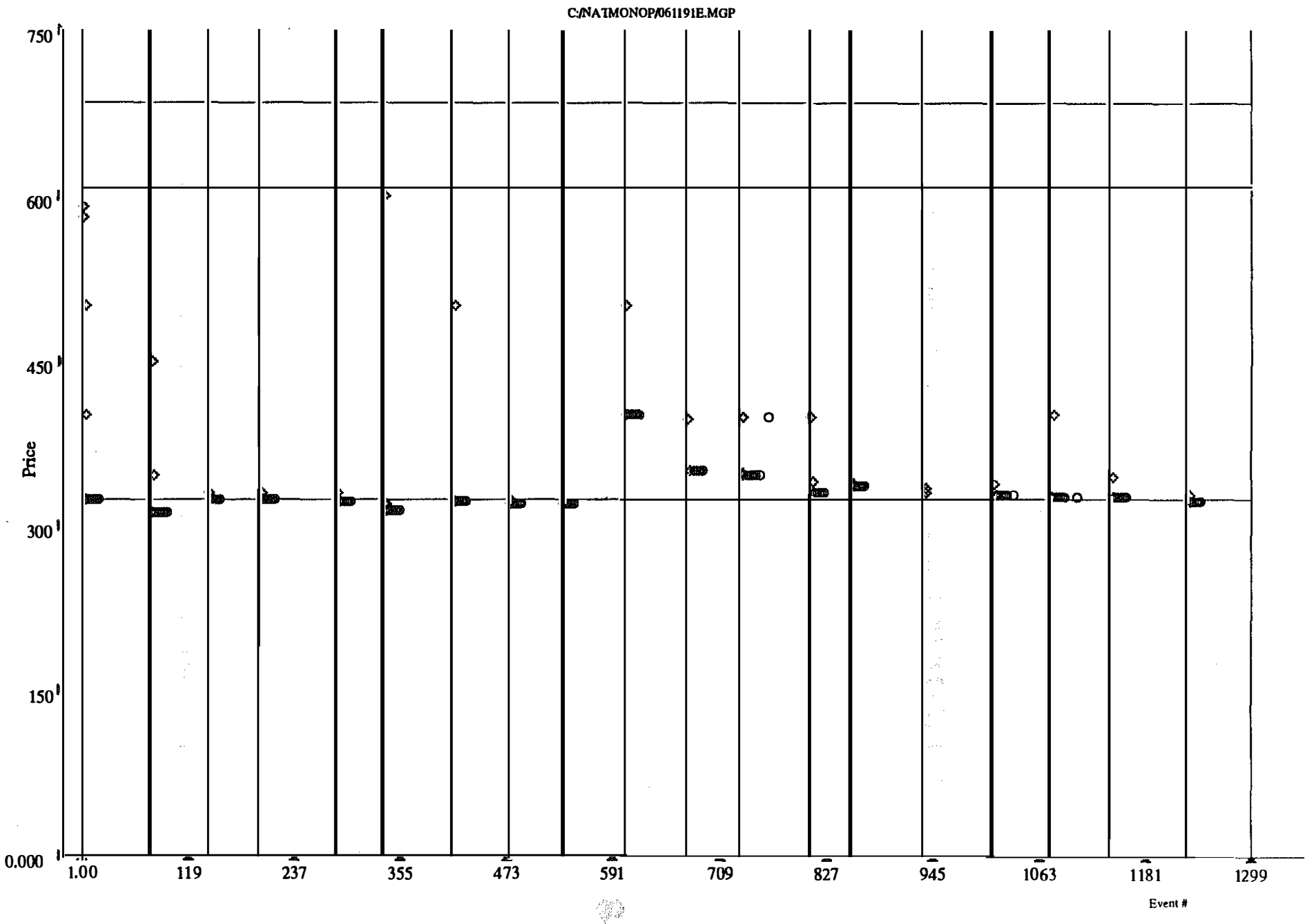

Figure 7: Period Prices and Quantities, all Periods, all Experiments

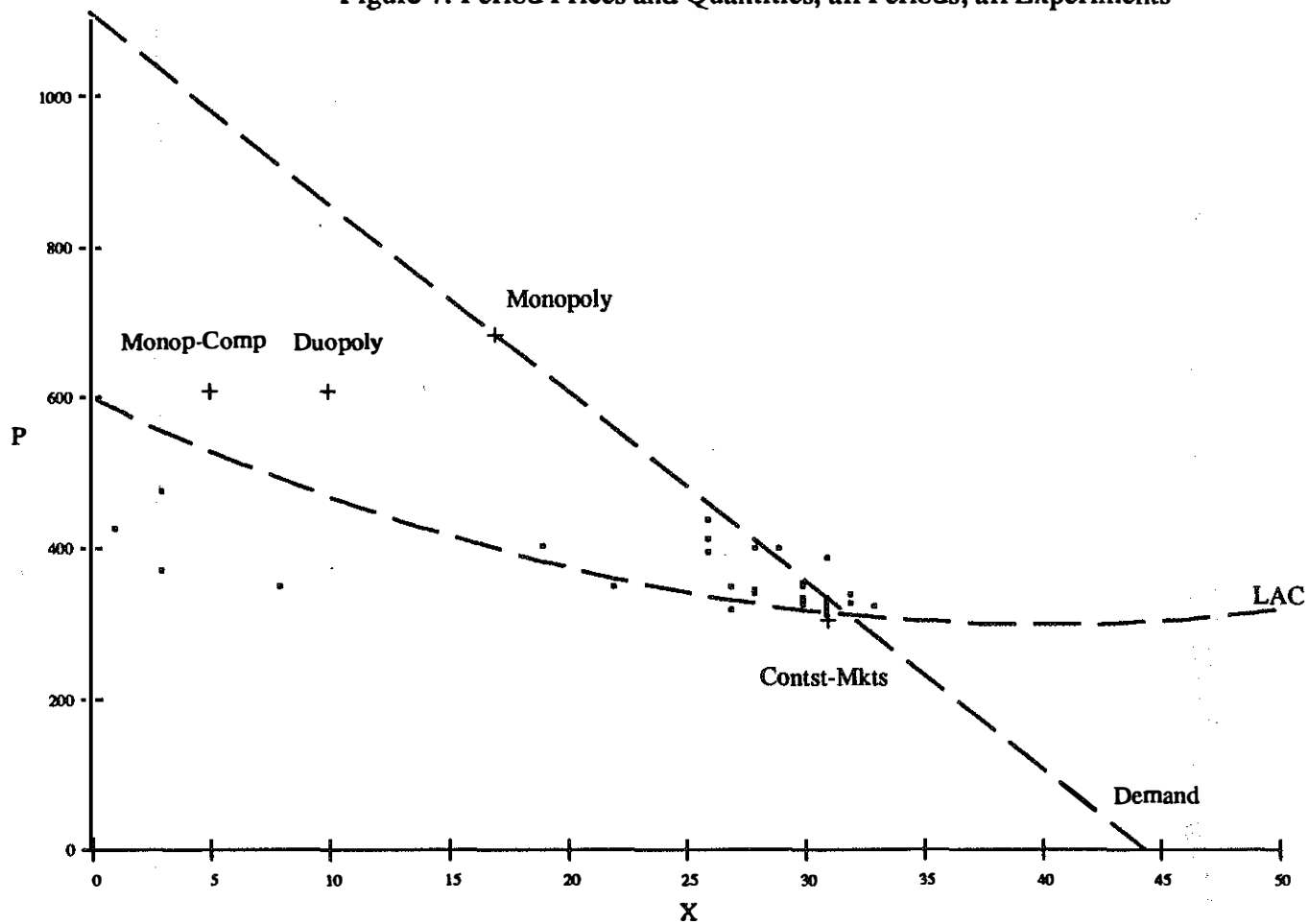

Figure 8

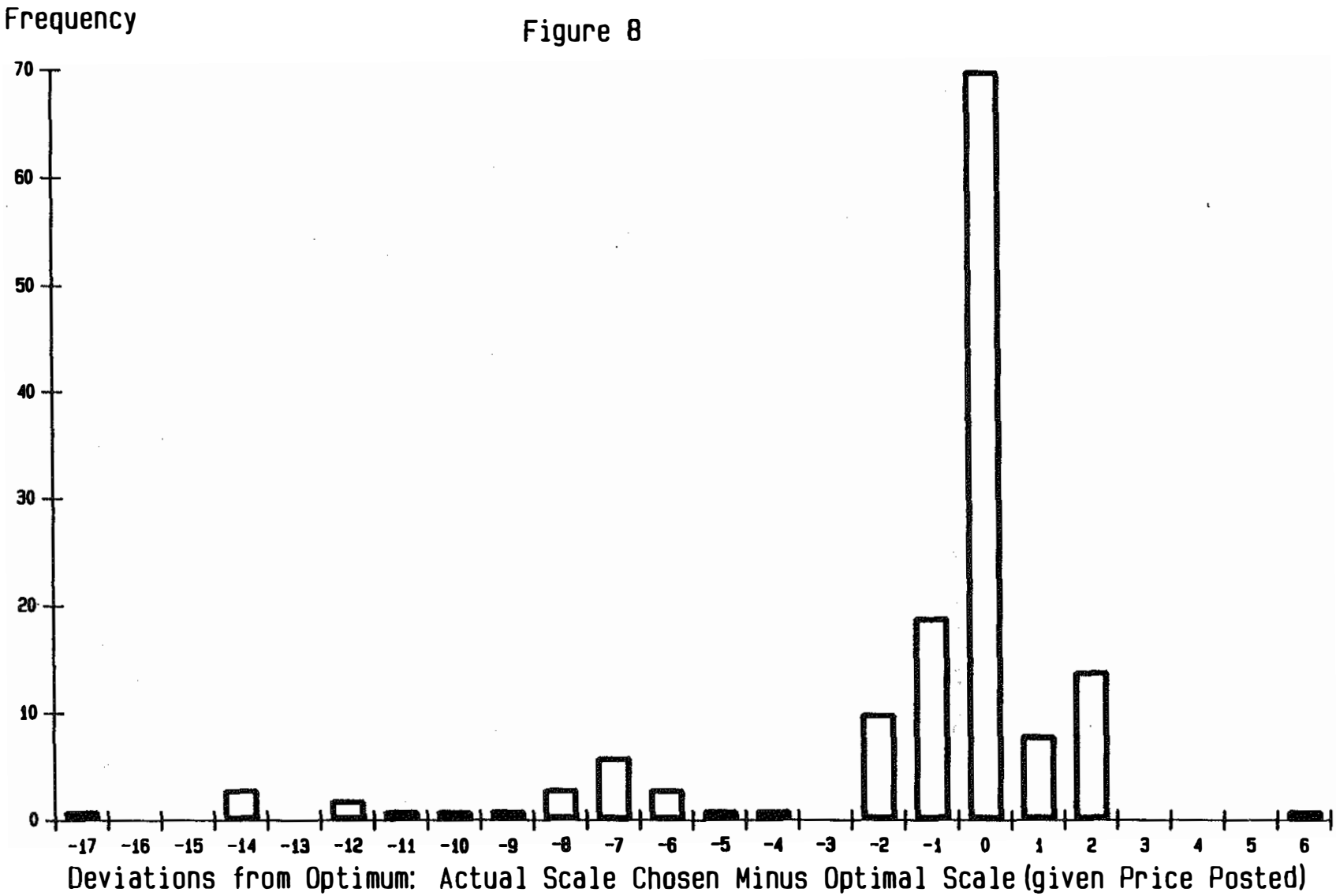
Frequency
70
60
50
40
30
20
10
0
-17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
Deviations from Optimum: Actual Scale Chosen Minus Optimal Scale (given Price Posted)

Figure 9

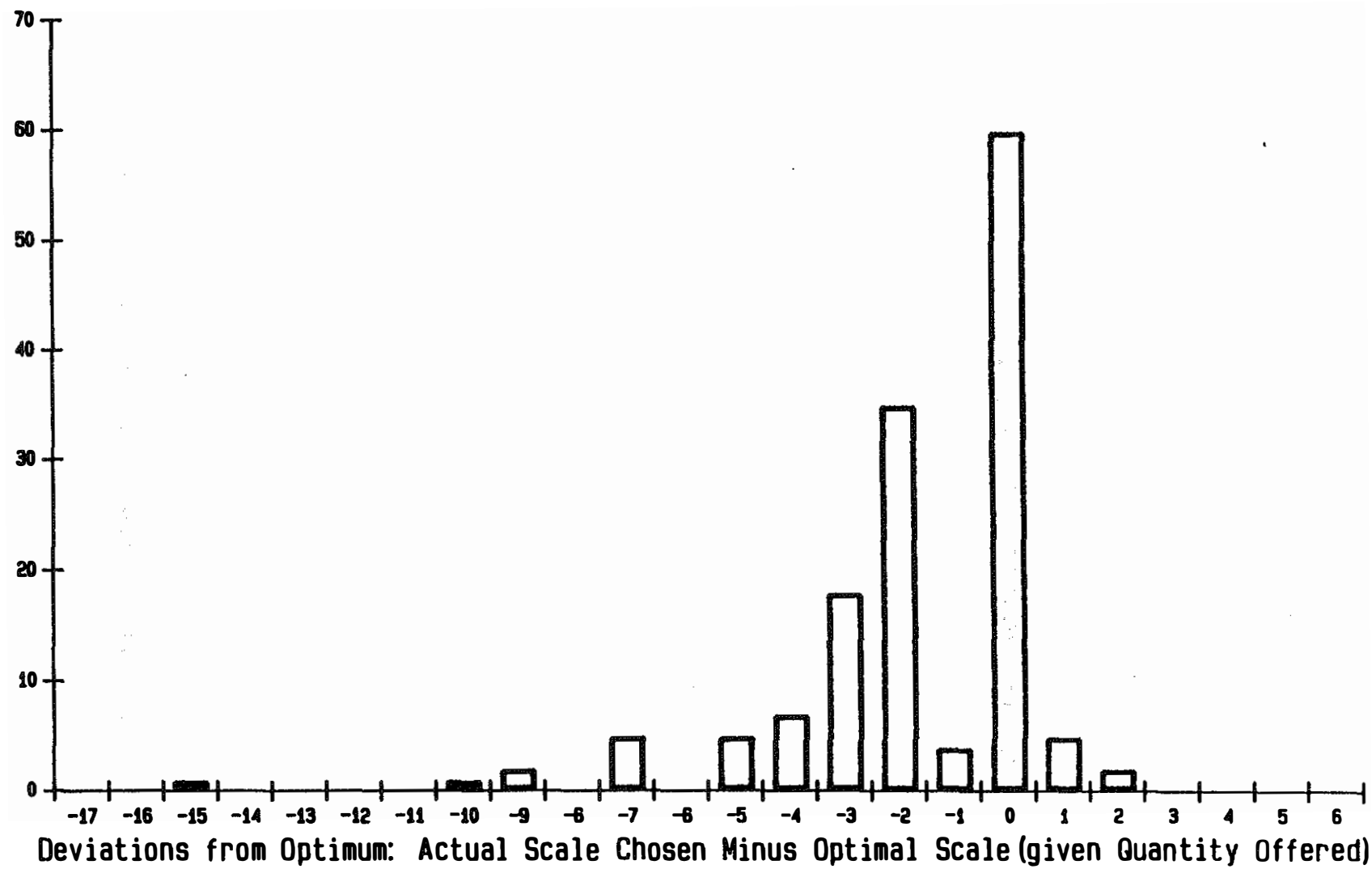
Frequency
70
60
50
40
30
20
10
0
-17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
Deviations from Optimum: Actual Scale Chosen Minus Optimal Scale (given Quantity Offered)

Table 1: Individual Incentives – Market A

	Demand							Costs
Agent/ Unit	00	01	02	03	04	05	06	All Seller Agents (07 through 13) had Same Cost
1	1000	1000	1000	1000	1000	1000	1000	550
2	1000	1000	1000	1000	1000	1000	1000	550
3	1000	1000	1000	1000	1000	1000	1000	700
4	400	400	400	400	400	400	400	700
5	400	400	400	400	400	400	400	700
6	400	400	400	400	400	400	400	700
7	400	400	400	400	400	400	400	700
8	400	400	400	400	400	400	400	700
9	400	400	400	400	400	400	400	700
10	400	400	400	400	400	400	400	700
11	400	400	400	400	400	400	400	700
12	400	400	400	400	400	400	400	700
13	400	400	400	400	400	400	400	700
14	400	400	400	400	400	400	400	700
15	400	400	400	400	400	400	400	700

Table 2: Demand Redemption Value Schedules Used in Market B
(Schedules Rotated among Buyers)

Schedule/ Unit	S_1	S_2	S_3	S_4	S_5	S_6	S_7
1	960	985	935	1085	1060	1035	1010
2	885	860	910	760	785	810	835
3	610	635	585	735	710	685	660
4	535	510	560	410	435	460	485
5	260	285	235	385	360	335	310
6	185	160	210	60	85	110	135
7	0	0	0	35	10	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0

Table 3

CUMULATIVE or TOTAL COSTS

		Production Schedule Choice ---------->																							
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Total	1	585	587	590	596	603	613	624	638	653	671	690	712	735	761	788	818	849	883	918	956	995	1037	1080	1126	1173
Units	2	1142	1142	1146	1154	1166	1182	1202	1226	1254	1286	1322	1362	1406	1454	1506	1562	1622	1686	1754	1826	1902	1982	2066	2154	2246
Sold	3	1675	1670	1672	1679	1693	1712	1736	1769	1807	1850	1900	1955	2017	2084	2156	2237	2323	2414	2512	2615	2725	2840	2962	3089	3223
	4	2168	2178	2172	2178	2186	2206	2236	2272	2316	2368	2428	2498	2572	2656	2748	2848	2956	3072	3196	3328	3468	3616	3772	3936	4108
|	5	2666	2684	2651	2649	2658	2674	2701	2739	2788	2844	2911	2989	3078	3174	3281	3399	3528	3664	3811	3969	4136	4314	4501	4699	4906
|	6	3174	3136	3114	3102	3102	3114	3136	3174	3222	3282	3354	3436	3534	3642	3762	3894	4036	4194	4362	4542	4734	4938	5154	5382	5622
|	7	3656	3603	3565	3540	3530	3533	3551	3582	3626	3687	3761	3848	3950	4065	4195	4338	4496	4667	4853	5052	5266	5493	5735	5990	6260
|	8	4136	4064	4008	3968	3944	3936	3944	3968	4008	4064	4136	4224	4328	4448	4584	4736	4904	5088	5288	5504	5736	5984	6248	6528	6824
V	9	4619	4525	4448	4390	4349	4327	4322	4336	4367	4417	4484	4570	4673	4795	4934	5092	5267	5461	5672	5902	6149	6415	6698	7000	7319
	10	5110	4990	4890	4810	4750	4710	4690	4690	4710	4750	4810	4890	4990	5110	5250	5410	5590	5790	6010	6250	6510	6790	7090	7410	7750
	11	5613	5484	5338	5233	5151	5090	5052	5035	5041	5068	5118	5189	5283	5398	5536	5695	5877	6080	6306	6553	6823	7114	7428	7763	8121
	12	6132	5952	5796	5664	5556	5472	5412	5376	5364	5376	5412	5472	5556	5664	5796	5952	6132	6336	6564	6816	7092	7392	7716	8064	8436
	13	6672	6456	6269	6107	5970	5860	5775	5717	5684	5676	5697	5743	5814	5912	6035	6185	6360	6562	6789	7043	7322	7626	7959	8317	8700
	14	7236	6986	6762	6568	6398	6256	6146	6062	6006	5976	5976	6006	6062	6146	6258	6398	6568	6762	6986	7238	7516	7826	8162	8526	8918
	15	7834	7541	7279	7046	6844	6671	6529	6416	6334	6281	6259	6266	6304	6371	6469	6596	6754	6941	7159	7406	7684	7991	8329	8696	9094
	16	8464	8126	7824	7552	7312	7104	6926	6784	6672	6592	6544	6528	6544	6592	6672	6784	6926	7104	7312	7552	7824	8126	8464	8832	9232
	17	9133	8751	8402	8086	7807	7561	7346	7170	7025	6915	6836	6798	6787	6813	6872	6966	7093	7255	7450	7680	7943	8241	8572	8938	9337
	18	9846	9414	9018	8656	8334	8046	7794	7578	7398	7254	7146	7074	7038	7038	7074	7146	7254	7398	7578	7794	8046	8334	8658	9018	9414
	19	10607	10122	9676	9267	8897	8564	8270	8013	7795	7614	7472	7367	7301	7272	7282	7329	7415	7538	7700	7899	8137	8412	8726	9077	9467
	20	11420	10860	10360	9920	9500	9120	8760	8460	8220	8000	7820	7660	7560	7520	7500	7520	7560	7660	7820	8000	8220	8480	8780	9120	9500
	21	12290	11692	11135	10621	10148	9716	9329	8983	8678	8416	8195	8017	7880	7786	7733	7723	7754	7826	7943	8101	8300	8542	8825	9151	9518
	22	13222	12562	11946	11374	10846	10362	9922	9526	9174	8866	8602	8382	8206	8074	7986	7942	7942	7986	8074	8206	8382	8602	8866	9174	9526
	23	14220	13495	12817	12184	11596	11057	10563	10114	9712	9355	9045	8780	8562	8389	8263	8182	8146	8159	8217	8320	8470	8665	8907	9194	9528
	24	15266	14496	13752	13056	12408	11808	11256	10752	10296	9888	9528	9216	8952	8736	8568	8448	8376	8352	8376	8448	8568	8736	8952	9216	9528
	25	16431	15569	14756	13994	13281	12619	12006	11444	10931	10469	10056	9694	9381	9119	8908	8744	8631	8569	8556	8594	8681	8819	9006	9244	9531
	26	17654	16716	15834	15002	14222	13494	12816	12194	11622	11102	10634	10216	9854	9542	9282	9074	8916	8814	8762	8762	8814	8916	9074	9282	9542
	27	18961	17948	16990	16085	15235	14436	13686	13007	12373	11792	11266	10793	10375	10010	9700	9443	9241	9092	8996	8957	8971	9036	9160	9335	9565
	28	20356	19264	18226	17240	16324	15456	14644	13886	13186	12544	11956	11424	10946	10526	10164	9856	9604	9408	9268	9184	9156	9184	9266	9408	9604
	29	21844	20670	19553	18495	17494	16552	15667	14841	14072	13362	12709	12115	11578	11100	10679	10317	10012	9766	9577	9447	9374	9360	9403	9505	9664
	30	23430	22170	20970	19830	18750	17730	16770	15870	15030	14250	13530	12870	12270	11730	11250	10830	10470	10170	9930	9750	9630	9570	9570	9630	9750
	31	25116	23769	22463	21256	20096	18995	17957	16980	16066	15213	14423	13694	13028	12423	11881	11400	10982	10625	10331	10098	9926	9819	9773	9788	9866
	32	26912	25472	24096	22784	21536	20352	19232	18176	17184	16256	15392	14592	13856	13184	12576	12032	11552	11136	10784	10496	10272	10112	10016	9984	10016
	33	28817	27283	25814	24412	23075	21805	20600	19462	18389	17383	16442	15568	14759	14017	13340	12730	12185	11707	11294	10948	10667	10453	10304	10222	10205
	34	30838	29206	27642	26146	24718	23358	22066	20842	19686	18598	17578	16626	15742	14928	14176	13496	12886	12342	11866	11458	11118	10846	10642	10506	10438
	35	32979	31246	29584	27991	26469	25016	23634	22321	21079	19906	18804	17771	16809	15918	15094	14341	13659	13046	12504	12031	11629	11296	11034	10841	10719
	36	35244	33408	31844	29952	28332	26784	25308	23904	22572	21312	20124	19008	17964	16992	16092	15264	14508	13824	13212	12672	12204	11808	11484	11232	11052
	37	37638	35696	33827	32033	30312	28666	27093	25595	24170	22820	21543	20341	19212	18156	17177	16271	15436	14680	13995	13385	12848	12386	11997	11683	11442
	38	40166	38114	36136	34236	32414	30666	28994	27398	25878	24434	23066	21774	20558	19416	18354	17366	16454	15618	14858	14174	13566	13034	12578	12198	11894
	39	42832	40667	38581	36572	34642	32789	31015	29318	27700	26159	24697	23312	22006	20777	19627	18554	17560	16643	15805	15044	14362	13757	13231	12782	12412
	40	45640	43360	41160	39040	37000	35040	33160	31360	29640	28000	26440	24960	23560	22240	21000	19840	18760	17760	16840	16000	15240	14560	13960	13440	13000

Table 4: Models and Predictions

	Market B						Market A			
Model	Number of Agents	Scale Choice	Market Price	Market Volume	Per Agent Volume	Per Agent Profit (Francs)	Number of Agents	Market Price	Market Volume	System Efficiency
1. Natural monopoly	1	M	684	17	17	4841	6	700	21	.80
2. Tacit collusion										
3. Cournot (symm) duopoly	2	G,H	609	20	10	1400	5	700	21	.76
4. Cournot (Asym) triopoly	3		609	20			4	700	21	.70
	(1)	D,E			6	498				
	(2)	E			7	670				
Monopolistic competition (Sym. Cournot)										
5. Quadopoly	4	C,D	609	20	5	351	3	700	21	.67
6. Quintopoly	5	C	609	20	4	228	2	700	21	0
7. Perfectly contested (competitive)	1	W	325	31	31	306	6	700	21	1.00
8. Over-contested	5	W	325	31	(31,0)	(306,0)	2	700	21	.87
9. Unstable ("Bertrand")										
10. Market collapse	0	-	-	0	0	-	7	300	21	.41

Table 5: Experimental Results:
Average Prices, Number of Entrants, Volumes, Efficiencies

	061191						062791						071891					
	A		B				A		B				A		B			
Period	$\bar{P}$	Vol.	$\bar{P}$	Vol.	N	Eff.	$\bar{P}$	Vol.	$\bar{P}$	Vol.	N	Eff.	$\bar{P}$	Vol.	$\bar{P}$	Vol.	N	Eff.
1	717	22	325	30	5	92%	584	25	412	26	3	83%	697	21	375	29	4	78%
2	691	21	312	31	3	92%	727	20	437	26	5	88%	704	21	370	30	5	85%
3	696	19	330	30	2	92%	683	21	400	30	2	89%	682	21	350	30	2	98%
4	685	21	324	31	2	97%	709	21	387	31	4	94%	693	21	340	28	3	93%
5	691	21	322	31	3	97%	702	21	386	30	3	96%	701	21	324	31	3	97%
6	703	21	315	31	4	95%	701	23	339	32	1	95%	703	21	319	31	2	98%
7	696	21	323	31	2	99%	702	21	330	31	4	95%	696	21	319	31	2	99%
8	700	21	320	31	2	99%	699	23	324	33	3	95%	697	21	318	31	3	97%
9	698	21	321	31	1	100%	696	22	-	0	0	40%	694	20	330	31	1	98%
10	701	19	400	28	2	93%	698	21	330	30	3	96%	696	23	325	31	2	96%
11	691	21	394	30	3	72%	700	21	326	31	3	97%	696	21	320	31	3	97%
12	698	21	398	28	3	90%	701	21	324	33	4	95%	696	21	321	31	1	100%
13	698	21	330	31	3	97%	700	21	335	30	2	98%	639	21	319	27	2	85%
14	700	21	335	31	2	99%	699	22	325	31	3	95%	696	21	330	31	1	98%
15	702	24	-	0	3	32%	700	22	330	31	3	95%	697	21	328	31	3	97%
16	700	21	328	32	2	92%	700	21	326	31	3	97%	695	21	324	33	3	97%
17	700	21	327	31	2	99%	700	21	327	31	2	99%	700	21	403	19	3	71%
18	700	22	326	31	2	97%	700	21	325	31	2	97%	697	23		0	3	34%
19	701	21	323	31	2	94%	689	19	437	26	1	93%	693	21	321	31	2	99%
AV.	698	21	336	29	2.2	91%	694	21	356	29	2.7	91%	693	21	335	27	2.4	90%

Table 6A: Market A Profit By Experiment, Period, Individual

	Experiment 061191							Experiment 062791							Experiment 071891						
Individual Period	07	08	09	10	11	12	13	07	08	09	10	11	12	13	07	08	09	10	11	12	13
1	-	305	660	-	-	-	-	-	-2700	325	300	-	290	-	-	-	-	316	-	213	300
2	250	200	300	-	-	-	267	-	275	-	870	-	-	-	-	-	-	369	-	317	-
3	298	250	300	0	-	-	267	-	296	310	300	-	320	200	301	-	-86	300	290	314	-
4	249	210	299	198	-	-	220	-	344	-	400	-	-	350	-	300	147	300	-	308	-
5	-	215	300	196	-	-	290	-	311	0	300	-	336	300	-	450	156	310	-	300	-
6	-	335	350	270	-	-	-	-	301	-	300	310	309	293	444	300	212	298	-	303	-
7	-	290	300	258	304	-	265	-	309	-	-	-	330	300	300	300	272	298	-	253	-
8	-	320	300	298	300	-	290	-	300	290	300	-	299	290	298	300	-	302	231	-	-
9	300	300	300	298	304	-	260	293	265	297	275	297	300	280	298	301	298	302	286	200	-
10	299	300	310	-	305	-	300	-	280	-	300	-	300	280	300	300	298	298	-	210	-
11	-	310	-	-	325	100	283	-	301	-	300	-	300	280	-	300	298	301	-	224	-
12	-	300	-	-	302	260	300	-	-	-	300	-	303	325	300	300	298	300	296	306	-
13	-	300	-	-	302	260	300	-	300	300	301	-	307	300	297	-902	-	300	300	219	-
14	-	300	300	-	300	300	300	-	300	-	301	-	304	281	300	298	296	298	300	220	-
15	-	302	-	-	308	298	350	-	300	-	300	-	300	303	-	305	298	305	-	221	-
16	-	302	300	258	-	303	345	-	305	-7300	-	300	302	301	301	298	-	302	-	186	-
17	-	301	300	-	303	301	300	-	300	-	300	300	302	303	299	300	-	300	300	-	-
18	-	300	305	-	302	298	300	-	0	-	300	300	295	300	288	303	-	303	-	226	-
19	-	301	300	-	301	306	320	-	201	294	260	290	300	281	298	300	-	298	300	232	-

Table 6B: Market B Volume and Profit

Experiment 061191

Individual	07		08		09		10		11		12		13	
Period	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit
1	0	0					30	120	0	0	0	0	0	0
2							31	-194	0	0	0	0		
3									0	0	30	180		
4									31	271	0	0		
5	0	0							31	209	0	0		
6	31	-101							0	0	0	0	0	0
7	31	240									0	0		
8	0	0									31	147		
9											31	178		
10							28	2016			0	0		
11	22	-1166			8	-2936	0	0						
12	0	0			28	504	0	0						
13	31	457			0	0	0	0						
14	31	612					0	0						
15	0	0			0	0	0	0						
16	0	0					0	0	32	480				
17	31	364					0	0						
18	0	0					31	333						
19	0	0					31	612						

Table 6B: Market B Volume and Profit..cont.

Experiment 062791

Individual	07		08		09		10		11		12		13	
Period	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit
1	26	1950							0	0	0	0	0	0
2	26	2600			0	0			0	0				
3	1	-456							29	2023	0	0		
4	31	2069			0	0			0	0				
5	0	0							30	900				
6	32	736			0	0								
7	0	0			0	0	0	0	31	364				
8	0	0							33	239				
9														
10	0	0			0	0			30	330				
11	0	0			0	0			31	240				
12	0	0	0	0	33	388			0	0				
13	0	0							30	480				
14					31	209			0	0				
15	0	0			31	364			0	0				
16	0	0			31	333			0	0				
17	0	0			31	364								
18	31	256			0	0								
19	26	2600												

Table 6B: Market B Volume and Profit..cont.

Experiment 071891

Individual	07		08		09		10		11		12		13	
Period	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit	Vol.	Profit
1	26	988	0	0	3	-1798			0	0				
2	3	-1048	0	0	0	0			0	0			27	263
3			0	0									30	870
4	28	112							0	0			0	0
5	0	0							31	178			0	0
6									31	23			0	0
7									31	116			0	0
8					0	0					0	0	31	85
9													31	302
10									31	302			0	0
11	0	0							31	132			0	0
12													31	178
13					27	-952							0	0
14													31	302
15	0	0							31	395			0	0
16					33	487			0	0			0	0
17					0	0					19	185	0	0
18					0	0			0	0			0	0
19					0	0							31	170

Table 7: Frequency of Scale of Plant Choice in All Three Experiments, All Periods

Scale	Number of Choices	
A	3	
B	0	
C	3	
D	1	Cournot triopoly and more
E	0	
F	0	
G	1	Cournot duopoly
H	0	
I	1	
J	1	
K	9	
L	0	
M	1	Monopoly
N	0	
O	3	
P	1	
Q	0	
R	2	
S	8	
T	7	
U	25	
V	21	
W	41	Contested market
X	3	
Y	15	

Table 8: Relative Frequency of Price Choices in Periods Beyond the Sixth and Expected Profits of Price Strategy

Price Range	Relative Frequency Low Price Choices		Posted Price Strategy	Profit if Low Price	Prob.* of Low Price	Expected Profit
$318 \leq p \leq 324$	19/91	.21				
$325 \leq p \leq 329$	21/91	.23	325	302	.79	238
$330 \leq p \leq 334$	13/91	.14	330	457	.56	256
$335 \leq p \leq 339$	6/91	.07	335	612	.42	257
$340 \leq p \leq 344$	3/91	.03	340	630	.35	220
$345 \leq p \leq 360$	6/91	.07	345	780	.32	250
$360 \leq p$	23/91	.25	360	1230	.25	307
			385	1980	.25	495

* computed neglecting ties.

Table 9: Number of Decisions to Enter the B Market in All Nineteen Periods: By Individual, By Experiment

Experiment	Individual Identification Number						
	7	8	9	10	11	12	13
061191	14	0	4	11	7	10	2
062791	18	1	14	1	14	2	2
071891	6	3	8	0	11	2	18

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